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The powder charge for a big naval gun. A 14-inch gun uses 460 pounds of powder for each charge

A NAVY AMMUNITION DEPOT—[See page 232]

A Religious Ceremony of the Hopi Indians*

An Initiation at Hano in Hopiland, Arizona

By J. Walter Fewkes, Bureau of American Ethnology

THERE are three pueblos on the East Mesa of the Hopi Indians called Walpi, Sitcomovi, and Hano. These villages, situated in Northeastern Arizona, are composite in population and have been affected in different degrees by influx of clans from different directions, the former homes of these clans now indicated by ruins. The inhabitants of Walpi are homogeneous. Sitcomovi, originally settled by clans from Zuñi, has lost the Zuñi idiom, but still retains a ritual which is essentially Cibolan (Zuñian). The latter pueblo is regarded by the Zuñi as one of their pueblos among the Hopi, its architectural features being those characteristic of Tewa pueblos on the Rio Grande. Architecturally Hano is also Tewan, and its inhabitants retain the Tewa idiom, its mythology and ritual being distinctly Tanoan, little modified by the neighboring Walpi.

The general character of the rituals in these three villages is known, but very little has been published on the ritual of the relatives of the Hano people who now live along the Rio Grande, especially as to the nature of the initiations of youths into societies of priests. The Hopi introduce personifications of ancestors in their pagan dances, and call the personators by the name, Katcinas (Cachenas), but apart from that our knowledge is fragmentary. At Hano this worship formerly survived in its original form, so that the following pages may give an idea of the initiation of boys and girls into the Katcina cult as once practised, possibly still persisting, in villages along the Rio Grande.

The month of February is an active one ceremonially in the calendar of the Hopi towns. It is the month when lustration rites are performed to purify the earth from the malign influences of a power which through sorcery is supposed to rule it in winter. In that month, the return of the Katcinas, led by their father, the Sun or Sky-god, is personated. The clans that came to the Hopi from the south personate the return of their Sky-god in December, the clans of Sitcomovi in January, but the Katcinas are supposed to return in February and to remain about the villages until July, when their departure is celebrated in an extended farewell festival. The February ceremony is called, in secular language, the Bean Planting, because beans are sprouted in the kivas to be symbolically used by the returning Sun-god to represent the fructifying forces of nature. These sprouted beans are given at that time to the heads of all the clans by the personator of the Sky-god, in answer to their prayers, as a symbolic promise of good crops during the year.

Of the various steps in initiatory rites from birth to maturity, in the life of pueblo children, none is regarded more important than the last, or that in which they are taught the mysteries of the Katcinas. A child under thirteen or fourteen years of age is not supposed to understand the nature of these supernatural beings, but to believe that from time to time family ancestors or spirits of the dead revisit the pueblos and receive prayers for the good of the tribe, after which they return to ghostly homes in the underworld, through the house of the sun far to the west. At this age they are among other things made acquainted with the fact that the Katcinas are not real supernatural beings, but personations by their own parents. But they must obtain this knowledge through initiation, some of the ordeals of which may be regarded as severe and are certainly calculated to bring out the moral courage of the novitiates. Many rites occur, one of which is a ceremonial flogging of children, which takes place in the presence of chiefs and other persons of the tribe. The rite at Hano, the subject of this article, has never been described.

To understand the meaning of this event and the place the Katcina cult occupies in the pueblo mind, it may be well to say a word on this subject before we pass to the consideration of the initiatory episode. In all their cults Hopi ceremonies show many indications of the worship of divinized ancestors, but this is especially true in those of the Katcina worship. The spirit dead are supposed to become Katcinas. The breath bodies of men pass to their future home, the underworld, a realm of the departed, presided over by the supernatural being called the God of Germs. The population of this underworld includes not only the spirits of those long ago deceased, but also those who have lately joined them. This ghostly population is supposed to have a social organization like that inhabiting the upper world, being as on earth divided into clans with related priesthoods, in all the conditions of life duplicating what is found among the living. There are male and female Katcinas, brothers, sisters, uncles, aunts, and various other relatives on the mother's side. The clans of the underworld, after death, bear names of the living, and are symbolically characterized. We have for instance, the Bear clan, the Badger clan, and others. Prominent among all members of each underworld clan are the oldest members, the ancestral parents of each clan, elevated to the cultus hero and heroine of the clan. The sun of course is father, and the earth, mother; they are common parents of all clans.

With this idea of clan arrangement of the dead in the underworld let us consider their relation to the living clans, for this is the foundation of this cultus. Clan relationship not being severed by death, the deceased members are regarded as still members of the clan, with the same obligation to the clan as when alive on earth. What is most important of all is that the powers of these spirit ancestors are regarded as most efficacious in answering the prayers of the living. In other words, the clansmen of earth of the Bear clan feel that by addressing prayers to their relatives in the underworld, they, with their aid, can bring about what they desire. This can be accomplished by the use of magic or other supernatural agencies. The personation of ancient members of the clans are "conjured up" to hear the petitions of those of their clan, still living.[1]

The February ceremonial has for its primary purpose a celebration of the advent of these ancestral personages, while that in July celebrates their return to their homes in the underworld. The flogging of the young initiates, like other ritualistic episodes, contain many archaic survivals that have a foundation in an early myth recounting how the cult hero was initiated by the Sun father, in like manner.

The flogging ceremony at Hano, here described, took place in the larger of the two kivas, or sacred rooms, just before sunset on the 14th of February, 1900. This rite has been witnessed more than once, but the variations are slight, at most, and have no great significance.

As with all pueblo ceremonies some time is occupied with preparation of the paraphernalia used, as it has to be renovated for the special purpose. The walls of the room were replastered and its floor thoroughly swept; all secular objects, as blankets in progress of weaving, were rolled up and put away, and smaller objects tucked in certain niches made in the wall for that purpose. Boxes containing soil, in which bean seeds[2] had been planted a week before, were concealed by a wagon sheet hung across the end of the room.

Three personators took the prominent parts in the child flogging, two of whom personated the great Sky-god and the third represented the earth, or old woman, who they believe makes the germs of life grow. The personator who flogs the children represents the father of all living on earth as well as inhabitants of the underworld.[3] An account of his costume may be instructive as embodying their symbolic conception of these supernaturals.

Each personator of the Sky-god wears on his head a mask-helmet, painted black, and adorned with clusters of feathers, long beards made of horsehair with attached feathers hanging from their chins. The body, upper arms, and thighs are painted, smut from the bottom of an old cooking pot serving for black paint. Markings are drawn with gypsum on the upper arms and thighs, and the legs and forearms are painted with the same material. Several ears of corn strung together form their belts from which, reaching to their knees, hangs a fringe of horsehair stained red, the body being naked. This crude representation of the Sky-god has the same symbolic marks as a wooden idol of this god on a Hopi altar, and is called Tuñwup Katcina.

The three personators dressed near a shrine outside the kiva on the trail below the pueblo and entered Hano from the east in order to preserve the illusion that they came from a distant place in the east, where the sun, whom they personify, rises. They entered the kiva where spectators had already assembled, and shortly after their appearance, the man personating the Earth-woman entered the room passing through the hatchway down the ladder bearing a flat basket with sacred meal to be used in the ceremonies.

It was about four o'clock, in the afternoon, when Anoté, the village chief of the pueblo, Hano, entered the kiva, bearing in one hand two wands made of the leaves of the yucca or century plant, in the other hand his medicine bowl and a badge, indicating his standing as a chief. He placed this badge on the floor and deposited his medicine bowl near it. He then poured into the latter a white liquid, making passes in sequence with his hand towards the six cardinal points: north, west, south, east, above and below. He then stripped off the spines from the margins and points of the yucca leaves, scooped some of the medicine from the bowl into one hand and drew the leaves through it. Aided by another man he tied several leaves together making two whips, which were laid on the placque containing the prayer meal brought by the old woman.

By this time spectators had begun to assemble in the room, each one taking his seat on the raised floor at one end of the room. When they were seated, a number of adults, men and women, each accompanied by a child, who carried an ear of corn called "mother" in one hand, filed into the kiva and seated themselves along the sides of the room. When all were gathered the chief began to construct a rude altar on the floor of the room. He first made a low ridge of sand a few inches high into which he planted, upright, a row of 20 wing feathers. In front of these feathers he outlined on the floor, with meal, three semicircular figures, side by side, representing raineloud, and added parallel lines of meal symbolic of falling rain. On the middle raincloud figure he set upright the badge of his office. A few feet in front of these figures near the firehole, he outlined with a line of meal a square figure crossed by two diagonals, on the junction of which, in the middle, he laid two small feathers. Having completed these preliminaries the chief took his seat back of the line of feathers and gave the signal that he was ready for the rite to begin. Shortly after, steps were heard on the kiva roof above followed by a voice hooting down the opening or hatchway, demanding permission to enter. The chief mounted the ladder and spoke to those above. Immediately there followed him down the ladder the two personators of the Sky-god, and a man dressed as an old woman. These three made a circuit around the fire hole six times, after which the earth woman personator holding the basket of meal and whips, took position near the bottom of the ladder, and the two Sky-gods stood, one on each side of the rectangular meal figure on the kiva floor. The latter then began a rapid dance bending and swaying their bodies and shouting to the assembled spectators. Each was then handed one of the yucca whips, previously prepared as mentioned above, after which they resumed their dancing, calling out loudly for the children to come and be flogged. In a short time a woman led forward a girl about 11 years old, whose garment had been removed from her back, and placed her within the square outlined with meal. One of the Sky-gods immediately struck the bared back with the yucca wand several times, all the while continuing to dance and shout. He then passed to the other side exchanging places with his companion and the foster mother bared her back and was flogged as her child had been before her. The two Sky-gods again exchanged places, and whips, as yet unused, were given to them, after which a man, possibly a father, led a boy forward, both stepping inside the rectangle of meal. The boy was first flogged on the back in the same manner as the little girl, and the father was struck several times also on legs and arms. As each person entered the paces occupied by the meal figure he took a pinch of meal, and raising it to his lips, threw it toward the Sky-god, uttering an inaudible prayer. The flogging continued until four children, and as many foster parents, or the men and women accompanying the children, had been treated in this way. Generally the punishment was received by the children without a flinch, but one of the

*Journal of the Washington Academy of Sciences.

[1] These returning clan members are represented by living members,' who, for the time being, believe that they really become the members of the spirit branch of the clan which they represent.

[2] These beans were forced to sprout in midwinter in a superheated atmosphere of the kiva, and were carried later by the Sun-god to represent symbolically fructification of food plants. Children were formerly taught that these sprouting beans are brought by a supernatural being, not being permitted to know that they were raised by their parents in the kiva.

[3] These men belonged to Hano clans. There are two Sky-gods in their mythology, one representing the sun, and the other the moon.

girls was frightened. The Sky-god was lenient, simply whirling his whip over her head, without striking.

At the close of the flogging of initiates, other children, mostly boys, not initiates, voluntarily came forward and stood with backs bared for the whips. They were struck, oftentimes rather severely. Then adults, one after another, including the old chiefs, stood up and were flogged, in the same way. As each person passed to the altar after receiving the blows he took a little liquid from the medicine bowl or meal from the basket, rubbed it on his wounds, without a word, and took his seat on the floor. The personators then left the room, after which the chief spoke at length, in Tewa idiom, to the assembled people. The author did not understand Tewa, but was told by an interpreter that he spoke to them on the meaning of the rite. He may have explained that it was a dramatization of an old legend and that the floggers were their own relatives personating supernatural beings. Following the speech the spectators then crowded around the altar, dipped their hands in the medicine, and took a handful of meal with which they rubbed their bodies, as both liquid and meal are considered salutary. At the close of the ceremony the children were led out of the room by their parents to their own homes.

On February 15th, the day subsequent to that in which the flogging above described was performed, there was celebrated at Walpi one of the most unusual of all rites of the Bean-planting festival. The main events of this ceremony were prayers to a supernatural being called Masauu, the god of planting, also known as the supernatural of the "surface of the earth." The dramatic reception of Masauu occurred in a Walpi kiva at 8 o'clock in the evening and lasted far into the night. It is such an unusual event, having been witnessed by the author but once, that although it has no direct connection with the child-flogging it is introduced here, for want of a more appropriate place.

On the night when Masauu's visit was personated all fires throughout the East Mesa were extinguished. No one was met in the streets. Women and children were in hiding in back rooms, and darkened house terraces were deserted, for the dread being is greatly feared by all the Hopi. Knowing that he was to be personated that night, the author resorted to the chief kiva, in Walpi, early in the evening, and found about 20 men engaged in decorating their bodies with white kaoline paint, drawing lines down their backs and legs and placing great daubs of white on their cheeks and hair. None of these men were masked, but all claimed they personated sisters or brothers of Masauu. Shortly after the author's entrance they began to sing their songs, containing strains of fine archaic Hopi Indian music, closely resembling in their cadences the song sung by the antelope priests in the well-known snake dance. While these songs were being sung a priest came down the kiva hatchway bearing two large hollow gourds, the surfaces of which had been painted black, and spattered with a wash containing glistening hematite. Each gourd was large enough to fit over the head and both were later worn as helmets by personators of Masauu. With these gourds the same priest brought two planting sticks of ancient form and two flat basket plaques which were laid with great reverence alongside the masks, near the firehole. At the advent of this man all those present ceased their singing and lighted their pipes for a formal smoke, during which the pipes were passed around, every man silently puffing clouds of smoke upon the masks. No one of that gathering spoke a word but each fervently prayed in sequence, beginning with the chief, at the conclusion of which they again returned to their usual songs. During these songs one of the chiefs raised the painted gourd helmet and talked directly to it praying for success of crops during the coming season. The songs rose and became so loud that no one could tell what was said, but the intent throughout were prayers to fertilize the fields that the corn might germinate and grow. Shortly after, while the men were still singing and the light of the fire had been shielded from all eyes by a blanket, in order to darken the room, a naked man silently and unannounced came down the ladder, not as is usually the case backwards holding on the rungs, but as one would descend a pair of stairs. Entering the room without making the customary request, "Am I welcome here?" he slipped around back of the row of singers, peering anxiously at the masks on the floor. He finally came to the front from his hiding and squatted by the fireplace. Cautiously he placed the strange human skull-like gourd helmet over his head, threw a rough blanket around his neck over his shoulders, and taking a planting stick in his hands assumed the kneeling posture which the Hopi take when they are planting on their farms, kneeling on one knee with the stick held vertically in his two hands. A second man who had entered the kiva, in the same way donned the other helmet and without a word took his position near his predecessor. The songs of the assembled priests then became more animated and finally died down to a low murmur and ceased. The two personators manipulating their planting sticks in rhythm kept time to the songs. At the conclusion of which the singers filed out of the kiva, but as each man passed the fireplace he placed in the flat basket on the floor by the side of the kneeling figures a feather, symbolic of prayer, for a successful harvest. As the last man left the room he halted for a moment at the fireplace, with one foot on the ladder rung and announced that in the spring, at planting time, a great ceremony to the planting god would occur in the fields to the west of Walpi. The prayers throughout this rite were particularly fervent, but so low they could not be heard even a few feet away. There was no loud talking and the faces of all were very serious as befitting the reverence for the beings addressed; many even went so far as to turn their faces away from the dread being to whom they prayed. After the departure of the men the two planting gods silently gathered up the feathered prayer offerings offered them, and departed.

The supernatural being called Masauu, also known as Eototo, was the chief cult being of the Fire people who migrated into the Hopi country, according to legends, from the East in prehistoric times. They formerly lived at a pueblo, now in ruins, three miles east of Walpi, called Sikyatki. A quarrel arose between Walpi and the inhabitants of Sikyatki, sometime before 1540, which eventually led to the overthhrow of the latter pueblo, whose people were incorporated in the former. Their cultus supernatural, Masauu, transferred to the Hopi pantheon, is still from time to time personated by descendants of the ill-fated Sikyatki, now fused with other Walpi clans.

The Main Drainage System of London*

By George William Humphreys, M.Inst.C.E.

Two papers dealing with the Main Drainage System of London are to be found in the Proceedings of the Institution of Civil Engineers. Sir Joseph Bazalgette, in 1865, described the creation of intercepting sewers which had been constructed shortly before that date, and Messrs. Worth and Crimp brought the subject up to date in 1897. The present position of the undertaking, at the end of 1916, is described in this communication. London was originally drained by means of the old open tributaries of the Thames, examples of which are the Counters Creek, the Westbourne, the Kilbourne, the Fleet, the Walbrook, etc., and these tributaries, although covered in, perform the same function to-day. At a later stage cesspools were introduced. Following upon the introduction of the water-closet in 1810, the overflow from the cesspools into the sewers, at first prohibited, became permissive, and in 1847 became compulsory. Cesspools were then abolished, and the state of the Thames became offensive by reason of these streams discharging within the boundaries of the Metropolis. In 1855 and 1858 the Metropolis Management Acts were passed, whereby the Metropolitan Board of Works was constituted, and *inter alia* was charged with the duty of providing and controlling a set of main or arterial sewers to drain the Metropolis, a similar duty as regards local sewers being entrusted to local parishes or vestries. A system of large intercepting sewers, which ran from the west of London, was decided upon and constructed. They discharged into the Thames at points below the Metropolis, the outlet for the northern side of the Thames being placed at Barking, and that for the southern side at Crossness. The discharge was effected on an ebbing tide, the sewage in the tidal intervals over the period of high water being stored inreservoirs located at the outfalls.

In 1884 a Royal Commission reported as to the state of affairs then existing, the discharge of crude sewage into the river at the new outfalls having been found to produce disagreeable effects, owing to the time taken for the discharge to reach open water, due to the daily tidal oscillations. In consequence of this report, works were undertaken to obtain precipitation of the sewage at the outfalls, the resulting sludge being taken out to sea and discharged in the vicinity of the Maplin Sands by means of specially constructed vessels.

Since 1897, the date of the last communication to the Institution, the London County Council, constituted in 1889, has carried out many large and important works for the enlargement of the system and the amelioration of the drainage conditions over the large and populous areas now drained. During the first ten years of that body's existence many important works were undertaken, but in 1899 it adopted a scheme, framed upon recommendations put forward by Sir Benjamin Baker and Sir Alexander Binnie, to enlarge the arterial system at an estimated expenditure of £3,750,000; and in 1903 it decided to expend, as a complement to these works, another £737,000, on a scheme prepared by Sir Maurice Fitzmaurice for storm-water drainage sewers and works. Upwards of £4,000,000 has been expended on this scheme up to date, the advent of the war having delayed completion of certain works. The old intercepting and outfall sewers, both on the north and on the south side of the river, have been practically duplicated and large provision has been made for the dealing with heavy rainfalls by the provision of storm-water sewers and pumping-stations. Although about 87 miles of sewers, the greater length of which consists of large main lines, have been constructed by the London County Council. Dependent as London is upon the tidal level in the Thames for a drainage discharge, the existence of a large area of 21 square miles in the heart of the Metropolis, the level of which is below very high water, and ten square miles of which is below the level of an average high water, makes the storm-water drainage problem a difficult one to deal with completely. The legislature has recognized this by imposing restrictions on the erection of dwelling-houses on the low-lying area when certain conditions prevail.

Several features of great interest presented themselves during the construction of the new intercepting sewers. The most marked was the comparatively small disturbance caused to the general community during the progress of the works, carried out as they were through the most populous parts of the Metropolis. A system of tunneling was adopted wherever possible, and very long drives were made, reaching in one case up to 6,129 feet. Wherever sewers passed near to valuable properties, the tunnel was driven with a shield and cast-iron segments were inserted, lined on the inside with concrete and brick-work. This method of construction proved also very valuable where bad ground was encountered, the Thanet sands heavily charged with water being satisfactorily dealt with by these means. The highest class of workmanship has been insisted upon even in small details. Where, owing to the lapse of time, defects have developed in the old works, improvements have been effected, but the main features of the scheme laid down and initiated 50 years ago remain in their original form, and have an equally long prospect of utility before them.

The population of the Administrative County of London at the last census (1911) amounted to 4,500,000, in round figures. The London County Council has admitted to its drainage system the sewage from certain outlying areas, as, in fixing the county boundaries, considerations of watershed areas were not adhered to. In agreeing to drain these outside areas, the proviso has generally been made that only sewage to the extent of about 50 gallons per day per head of population on the area served is to be delivered and dealt with. Storm-water flow is therefore excluded. The system therefore dealt with an estimated population of 5,334,731 in 1911, and the indication given of change in these figures to the present date (1916) is that, as regards the county area, there is a slight diminution, while there is an increase in the out-county areas. The total quantity of sewage computed to have reached the outfalls was about 200,000,000 gallons a day in 1894-95, and 280,000,000 gallons a day in 1914-15, an increase of 80,000,000 gallons per day over the discharge of 20 years ago. Compared with the past this is composed in part of rainfall that formerly was discharged by means of the old river-valley sewers and was not intercepted.

The effect of the elimination of the greater part of the suspended solids at the outfalls, and their conveyance to sea as sludge, when this operation was in working order in or about the year 1893, was immediate. The change in the condition of the foreshores and the river has been remarkable. The cost of removal of the sludge to sea during the past 10 years was on the average, for working alone, 3.8*d.*, or, including capital charges 4.4*d.* per ton of sludge dealt with. The cost of precipitation over the same period has amounted, on an average, to £1 3*s.* 4*d.* per million gallons dealt with, including capital charges. The discharge of the sludge in the outer estuary of the Thames has been accomplished without any prejudicial results, and certainly by no other method could a like result, as regards low cost and immunity from nuisance or harm, have been attained. The London County Council has purchased about 750 acres of land in the neighborhood of and surrounding its outfalls. This has the effect of isolating the outfall-works, and at the same time the land would be available if later on future developments should demand the treatment by tried bacterial or other processes of either some portion of the effluent or the sludge.

The capital outlay on the system over the period 1856 to March 31st, 1914, amounted to about £12,500,000, of which approximately one-half has been repaid. The net expenditure for maintenance for the year 1913-14 was £303,402, towards which out-county areas contributed £28,467. The rate charges for main drainage services (capital and maintenance charges) in the county area amounted to 3.355*d.* In addition to this, Londoners pay the local drainage rate, which, roughly speaking, is 1*d.* in the £ averaged over all the borough council areas.

*Abstract of a Paper read at the ordinary meeting of the Institution of Civil Engineers and reported in *The Architect and Contract Reporter*.

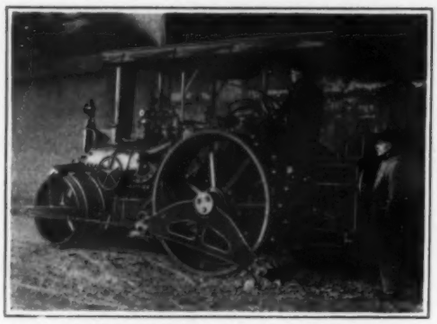
Picking Ice in City Streets With a Scarifier Roller

THE accompanying illustration shows a scarifier roller picking ice in Worcester, as utilized to advantage by the Street Commissioner during the winter when the ice was frozen down to the street surface. This is about the hardest material to remove which is encountered in the street department work. It is much harder than any dirt excavation, and comes away much less freely than rock would, as one gets only a small piece at a time under ordinary conditions, when the ice is frozen to the pavement.

In this city they have had a great deal of trouble from the ice accumulating in the car tracks, the wheels of the trucks, together with the salt, forming quite a depression where the rails are, leaving the center high, and the outside roadway high above the rail. This feature, with the increased use of trucks during the winter time, makes it a dangerous and disagreeable proposition. Any truck getting down into the slot or depression finds it extremely difficult to get out.

The Commissioner states that they are obliged, owing to teaming conditions there, to leave considerable snow on the street. This snow turns to ice, and even the railroad companies find great difficulty in operating on account of the boxes under the center of the car dragging on the ice between the trucks. The old method of hand-picking is a very costly and slow process. They have tried different methods of scarifiers on road machines, and as these did not do the work they tried an invention of an ice leveling company, which worked but a very short time before it was "hors de combat."

Finally the Commissioner originated this method with the scarifier roller. The rear wheels of the roller may be equipped with either short stub picks, chains or cleats, similar to those in use on traction engines. This forms the traction and holds machine steady. The front wheel is equipped with two sections of heavy "T" iron, shrunk and bolted onto the front wheels of the steam roller. This enables the operator to steer the machine, which he cannot do with the front wheels bare. With this equipment they have been able to do an increased amount of breaking up of ice in the streets, at a small expense, and quickly. It gives the steam roller something to do in winter, when it is usually laid up in the shed, with nothing in view, and it is held that this is the first time anything of this nature has been applied to a steam roller proposition for winter work.



Scarifier roller picking ice on a city street

The Metronome in the Workshop

THE necessity for manufacturing munitions in great abundance and as fast as possible has induced private industry to regulate existing installations rapidly and create implements appropriate to new needs. Moreover, the possibility of doing work systematically, in the full acceptance of this term, has facilitated the intensive production demanded by circumstances.

The rational organization of "work in series" does not consist, as many persons imagine, merely in executing successively a large number of pieces identical with each other, as if each of them were isolated: it is true that the workman attains a greater skill and consequently a greater output by virtue of repetition; but this single point of view would have only a secondary interest. The principal advantage of this mode of production is to permit the thorough study, not solely of the means of execution of the work, but also of the division of the work among the various individuals who are to take part in it, in order to reduce chance to the minimum.

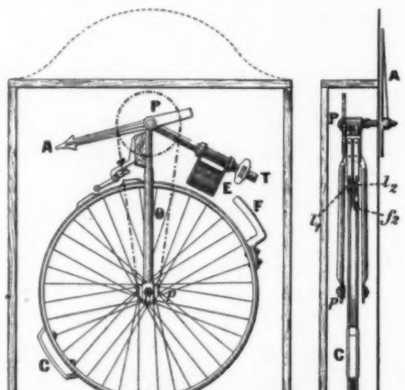
The result sought will be obtained when the elementary items of work into which the total work has been subdivided are accomplished in the normal periods of time planned, these elementary periods of time being themselves the exact multiples and sub-multiples of each other; in these conditions, if the *personnel* at one's disposal be judiciously distributed, each stage of the manufacture will be terminated at the given point by the turning out of the finished product.

It is not, therefore, merely a question of working as rapidly as possible, it is necessary to work *in time*, to synchronize all effort, in order to avoid in each phase of the manufacture a systematic advance or retardation, which might easily result in encumbering or damaging the work in one of the subsequent phases.

Thus the manufacturers have been led to give great importance to the factor of "time." From this point of view the *rôle* of foreman (contremaitre), is very analogous to that of the leader of an orchestra, who, armed with his baton, takes care that each of his musicians scrupulously respect the given cadence; in the workshop, too, the cadence must remain constant during the given period of work. Hence the orchestra-leader's arm may here be advantageously replaced by a mechanism analogous to the metronome, whose automatic regularity perfectly fulfils the conditions.

We have recently come across a very striking application of those ideas in a work-shop for tempering shells. M. Georges Charpy, director of the plant, conceived the idea of placing before the eyes of the workmen a large dial upon which there revolves a pointer or hand visible from different points of the room, and making perceptibly one revolution per minute. Each of the workmen charged with a specific operation (introducing the shell into the tempering furnace, taking it out, putting it into the annealing oven, its issue therefrom, testing the degree of hardness, etc.), performs it each time during the period occupied by the needle in passing through one of the intervals marked off by incandescent lamps. The operations thus succeed each other at regular intervals, without orders, and with remarkable regularity. The apparatus employed to measure the time is a sort of electric clock, easy to make.

Its exterior aspect is that of a wooden box, whose dimensions are 0.85 meters by 1.05 meters by 0.18 meters. Upon the upper part of the front surface, forming a dial there revolves a large aluminum pointer *a*, whose course is marked off by three equidistant electric lamps. The



motor mechanism and the transmission of the motion to the pointer are effected by the rear driving mechanism of a bicycle with a free wheel upon whose felloe is fastened a weight *c*. The wheel, with its extra load forms a pendulum identical with the pendulum of an ordinary clock.

Let us suppose that the pendulum is started from its position of equilibrium: by the action of the sprocket wheel *p*, the large pinion *P*, and consequently the hand pointer *A*, which is fixed upon it are moved, in the half-period of oscillation corresponding to the rotation of the wheel towards the right; during the following half-period (rotation in the inverse direction), they remain fixed. Consequently the pointer or hand *A* begins to revolve, and the greater the amplitude of oscillation of the pendulum, the sooner it will accomplish the complete circuit of the dial.

To prevent the movement coming to rest it is necessary to keep it going; to this end, following the arrangement often adopted in the synchromization of pendulums, an electric coil *E* is fastened to the arm *T* of the frame, and a bar of soft iron *F* is fixed upon the wheel. If when the apparatus is started, a current of electricity is sent into the coil at the moment when the soft iron core *F*, is about to penetrate it, the latter is attracted and draws the wheel with it; this attraction will be prolonged until there is reached the maximum position of movement regarded as desirable, when the current is interrupted and freedom of oscillation is given to the system.

In short, at the end of each half-period of oscillation, in the inverse direction, the pendulum receives a small impulse of kinetic energy, which permits the amplitude to remain constant. The automatic closing and breaking of the circuit are insured and suitably regulated by the contacts f_1 and f_2, each mounted on one of the flanges of the felloe and activating the levers l_1 and l_2; these levers are united solidly with the frame and control a relay situated in the box of the metronome.

To simplify the installation provision has been made for the employment in the circuit of the apparatus of a current of 250 volts from the power of the plant.

Experiment has proved that the use of this apparatus insures perfect homogeneity of the thermic treatments of the shells, great regularity in the progress of manufacture, and the maximum product compatible with technical considerations and the means at command. Moreover, since the hourly product of the workroom is known, the work in the finishing room can be satisfactorily regulated.—*La Nature.*

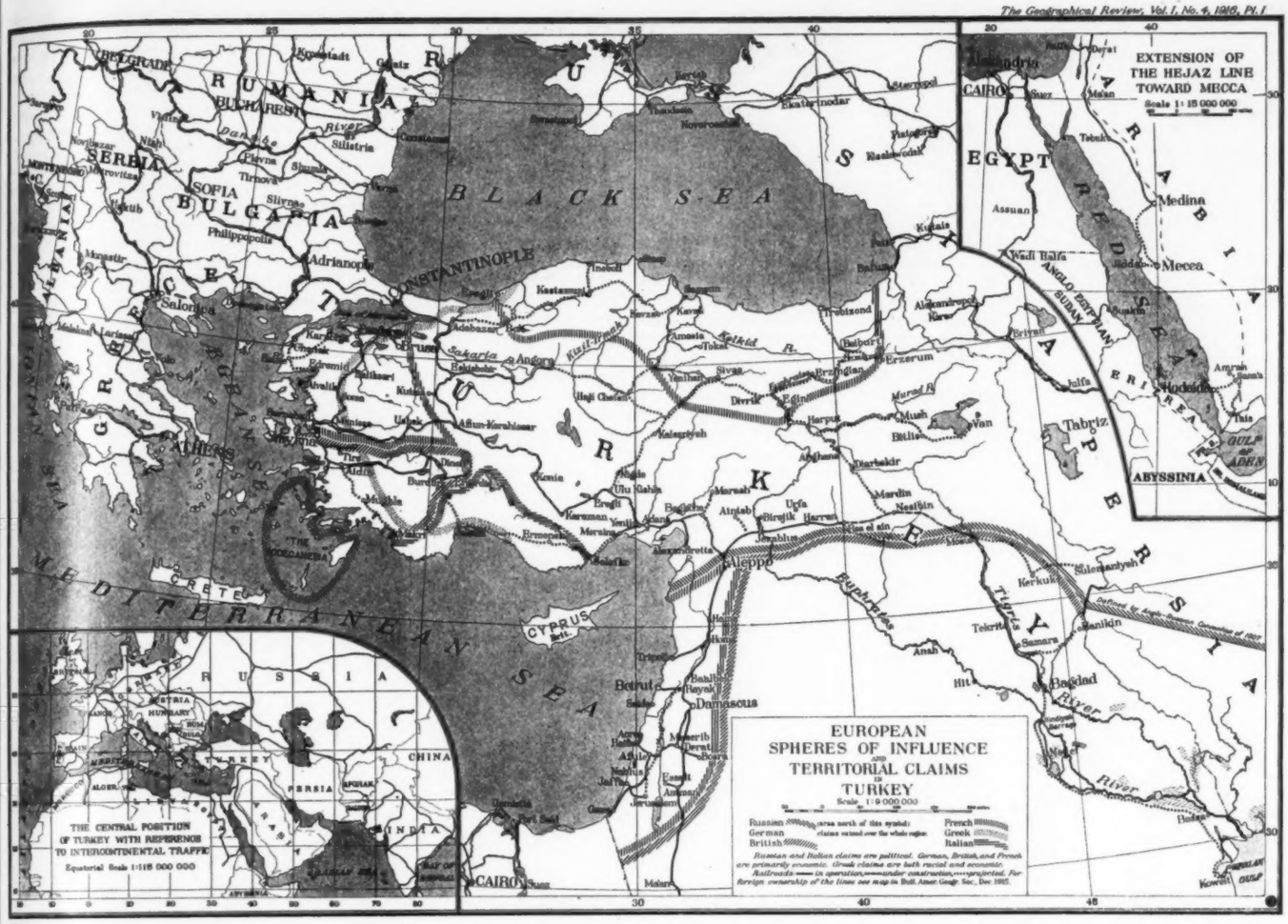
Additive Compounds of Trinitrobenzene

POLYNITRO compounds of the aromatic series possess the property of forming additive compounds with aromatic hydrocarbons, amines, phenols, phenolic ethers, and sulphur compounds. A large number of additive derivatives of *s*-trinitrobenzene have been prepared and analyzed. In the majority of cases the compound is obtained by mixing theoretical proportions of the components and crystallizing from a suitable solvent, usually alcohol, but occasionally benzene. In other cases the compound was only obtainable by using an excess of the hydrocarbon or base over the amount calculated to form the trinitrobenzene derivative. As a rule the color of the additive compounds with hydrocarbons is not so marked as that of the corresponding amino- or hydroxy-derivatives; the color of the hydrocarbon additive compounds is usually yellow, but anthracene gives a bright red compound. It would appear that the formation of compounds is due to latent valencies of the nitro-groups and of the aromatic residues of the hydrocarbon; the hydroxy-, alkyloxy-, amino-, and alkylamino-groups act mainly as auxochromes and tend also to increase the stability. As regards the combining proportions, it would appear that the number of trinitrobenzene molecules combining varies with the number of independent aromatic nuclei in the other component; in this connection, however, a condensed system of several benzene or benzene and heterocyclic rings counts as a single nucleus. Compounds in equimolecular proportions are formed with naphthalene, anthracene, phenanthrene, aniline, etc. Compounds of two mols. of trinitrobenzene and one mol. of the substances are formed with stilbene, diphenylamine, etc. There are, however, exceptions to the rule, and several substances form two types of additive compounds containing one and two mols. of trinitrobenzene respectively. Quite a number of substances containing two or more independent aromatic nuclei combine in equimolecular proportions; in a few cases one mol. of trinitrobenzene combines with two of the substance.

As a rule the additive compounds obtained from naphthalene derivatives are more stable than those derived from corresponding benzene compounds. A series of compounds has been prepared from amino derivatives of phenanthrene, anthracene, acenaphthene, and fluorene. With the exception of aminofluorene all these compounds were formed by the union of equimolecular proportions of trinitrobenzene and the base. In this series, the colors of the additive compounds are relatively deep, being, as a rule, either black or deep brown, whereas those of the naphthalene series are mainly orange-yellow or red. The compounds are comparatively stable and can be crystallized from most solvents, but determinations of molecular weights showed that, in dilute benzene solution, dissociation into the components is almost complete. These compounds, on the whole, resemble the additive compounds from the naphthylamines, but several of them appear to be incapable of yielding acetyl derivatives.—*Notes from the Journal of the Chemical Industry on a paper by* J. J. SUDBOROUGH, and S. T. CADRE and J. J. SUDBOROUGH in *Chem. Soc. Trans.*

Inviolable Envelopes

THE ordinary "mucilage" with which the flaps of envelopes are gummed is composed of gum arabic or dextrine, and is only too amendable to the persuasiveness of moisture or "steaming" in the hands of the unscrupulous. Persons who wish to guard their enclosures, whether emotional or financial, against such pilfering can seal their letters by a method referred to in the Annales des Télégraphes. This consists in applying white of egg to the flap of an ungummed envelope, then, before it has time to dry of itself sealing it by passing a hot iron over it. If the temperature of the latter is from 90° to 100° C., the albumen will be coagulated and the two surfaces of the paper will be solidly united and water-tight.



Europe at Turkey's Door*

Historic, Geographic and Economic Data Bearing on Its Future

By Leon Dominian

THE dismemberment of Turkey is the goal which Europe has steadily aimed at since the loss of the Holy Land of Christendom. It will also be the last chapter in the long history of Europe's commercial conquest of western Asia. Three causes operate in favor of this partition: the country is rich in natural resources; it is held by a people whose incompetence to convert nature's gifts into use or profit is historically patent; it occupies a commanding situation with reference to the trade of Europe with Asia or Africa. These three points are fundamental in the solution of the Turkish problem.

The European nations most vitally concerned in the dismemberment of the Sultan's dominions are four in number. Great Britain's interest is born of the Empire's relation to Egypt and India. The cause of Russian progress depends on the country's access to warm seaports. Germany, the newcomer on the scene and a land power, is engaged in extending her land area. To her sons Turkey offers an attractive colonization area and at the same time the land route which will render them independent of the sea way passing through Suez to the East. As a colonial power of the first magnitude no less than on account of her millions of Mohammedan subjects, France cannot be disinterested in the fate of the core-lands of Islam.

Turkey is the Asiatic pendant of the intercontinental highway represented in Europe by the Balkan Peninsula. Through Asia Minor it provides a convenient causeway between Asia and Europe. Through Arabia it connects Asia with Africa. Again, through the combined position of Asia Minor and Syria it makes possible continuous land travel from Europe to Africa. Turkey is thus the center of the eastern hemisphere. Mastery of its territory is bound to turn the flow of intercontinental trade into the lap of its holders. The entire history of European conflict over Turkish lands is wrapped around this geographical fact.

*From *The Geographical Review*.

Italians were the pioneers of European trade with Turkey after the consolidation of Ottoman power. In this, Genoese and Venetian traders merely followed in the footsteps of their fathers, whose dealings with the Byzantines had been considerable. French merchants were not slow to compete with the Italians. In the fifteenth century English drapers and commissioners begin to appear on the Levantine scene. Germans show signs of activity a hundred years later but confine their operations mainly to the European dominions of the Sultans. From these beginnings to the twentieth century territorial claims of each of the great powers over Turkey is but a natural economic unfolding.

Turkey's remarkably central position in the eastern hemisphere converts the country into the threshold of Great Britain's Asiatic dominions as well as into the natural land connection between British Africa and British Asia. From India and the British zone in southern Persia as defined by the Anglo-Russian convention of 1907 westward to the sultanate of Egypt, southern Turkey, represented by Lower Mesopotamia and Arabia, is the only stretch of territory in which the British government does not exercise direct control. Even so, the task of consolidating British influence in these two regions of the Turkish Empire is well advanced.

In the economic life of modern Mesopotamia British influence is paramount. About 90 per cent of the trade of Basra and Bagdad is in British hands. Steam navigation on the Euphrates and Tigris, with its attendant privileges of transportation, is a monopoly exercised by Englishmen. This means that all Persian trade which enters or leaves the country through its southern Turkish border must pay toll to British capital. Most important of all, the stupendous task of reclaiming the great twin river valley has fallen to the share of English enterprise.

The area of agricultural lands in Lower Mesopotamia is generally calculated at ten times the total surface of farming land in Egypt. The territory suited for cultivation extends northward from the Persian Gulf roughly to a line drawn from the bend of the Euphrates at Anah to Tekrit on the Tigris. Its eastern boundary is defined by the Zagros and Pusht-i-Koh Mountains. On the west it is limited by the Great Syrian Desert. Thus delimited the region is the great alluvial plain of Mesopotamia. A stretch of land remarkably rich in humus, it only needs to be administered justly and developed properly in order to become highly productive.

In olden days the entire district was one vast field. Its fertility had earned for it the name of granary of the world. Herodotus extols its productivity: ". . . In grain it is so fruitful as to yield commonly two-hundred fold and, when the production is the greatest, even three-hundred fold. The blade of the wheat plant and barley plant is often four fingers in breadth."[1] In the their present state the once productive lands present the appearance of a desert. The old irrigation ditches are in ruins. Mile upon mile of bare clay-soil or dreary marsh occupies the site formerly given up to grain growing.

The reclamation of this parched country was undertaken in 1908 by British engineers headed by Sir William Willcocks. In the delta region of Mesopotamia, comprising the entire drainage valley extending south of Hit on the Euphrates and of Samara on the Tigris, between twelve and thirteen million acres of first-class irrigation land were to be converted into productive areas. In spite of Turkish opposition the work advanced with sufficient rapidity for the Hindiyeh Barrage to be inaugurated in 1913. After the lapse of twenty centuries a handful of plucky northerners had, notwithstanding well-nigh insurmountable obstacles, put the last touches

[1]Bk. I, Chap. 193. Babylonia's fertility is also noticed by other ancient writers. Cf. footnote in Rawlinson's Herodotus, Vol. I p. 258, Appleton, New York, 1859.

to the project of drainage regulation begun on the same spot by Alexander the Great, the construction of a new head for the Hindiyeh branch, or Pallocopas, having been that monarch's first public work in Babylonia.[1]

In the Persian Gulf British influence advanced in great strides during the present century. Within the last ten years the policing of the gulf waters and harbors has been undertaken by English men-of-war. An appreciable curtailment of the trade in firearms followed the tracking of gun-runners by British captains. The important towns of the Persian or Arabian coast are virtually British possessions. Bushire[2] on the eastern shore, Koweit on the west are protectorates. The trend of it all is to advance India's western frontier to the line of the Euphrates.

For Great Britain's attitude toward Turkish politics is determined at Delhi rather than London. As ruler of the most numerous political group of Mohammedans in the world, the King of England's residence in his European capital cannot affect India's geographical exigencies, among which the maintenance of a clear road from its shores to the mother island is of prime import. Thus the establishment of a British zone in southern Persia and the attempt to substitute British law in Mesopotamia, where, after all, the Sultan's authority is most precarious in character, merely reveal England's necessity for consolidating her power over the approaches to her great Asiatic colony.

In dealing with Indian geography and the vast body of Mohammedan Hindus attention is necessarily riveted by the question of Arabia. England's stewardship of the peninsular tableland seems inevitable. Not that the huge wastes of burning sand contain resources convertible into profit. But Arabia to-day, in virtue of its position, represents a wedge of barbarism driven against the civilizing influence exerted by England in Egypt and India. The danger of its proving to be the generating center of revolutionary currents which will involve British colonial policies in destruction is not mythical. Millions of Indian Moslems turn daily in prayer toward the direction of the Kaba'a. A glance at India's history suffices to reveal the extent to which the Gulf of Oman has linked the two peninsulas.

To detach Arabia from a shadowy allegiance to the Sultan of Turkey and bring it within the uplifting sphere of British activity was part of the political program elaborated at Downing Street after the bombardment of Alexandria in 1882. In pursuance of this policy British influence is now markedly felt along Arabia's three coasts. It is firmly planted on the southeast, where Arabia is nearest to India. From Koweit to Mascat every petty potentate exercising an antiquated patriarchal authority has learned to rely on British protection against Turkish encroachments. Aden on the southwest coast is a lone outpost of civilization from which Western ideas radiate outward and occasionally attain the plateau land of Yemen or the niggard wastes of Hadramut. This British seaport is the natural outlet of Yemen. Products of the favored districts around Kataba, as well as between this town and Sana'a, can be transported with greater facility to Aden than by way of the arduous routes which lead to Red Sea harbors.

The question of Arabia involves other considerations. Mecca and Medina, its holy cities, are essentially the religious center of the Islamic world. From the district of their sites Mohammedanism has spread about 4,000 miles in both east and west directions. Among Arabs as well as the majority of Mohammedans outside of Turkey, desire for the restoration of the caliphate at Mecca is strong. The Arabs, especially, consider the sultans as usurpers of the title. Selim I had been the first to adopt it after the conquest of Egypt and Arabia in 1517. The Arabs, however, refuse to recognize the right of any but descendants of the Prophet's family to this supreme post of the Mohammedan ecclesiastical hierarchy. This explains why any ambitious leader who succeeded in circulating the report of his relationship with Mohammed's progeny always secured a following among his co-religionists in Asia or Africa.

As usual, the Arabs have vented this chief grievance of theirs in English ears. They found ready sympathy among British officials no less than among the leaders of their faith in Egypt or India. The complete severance of the Mohammedan caliphate from the Turkish sultanate will, therefore, be a probable result of Franco-British success in the present war. The reëstablishment of the Prophet's family in its hereditary right and capital will have the advantage of providing Islam with a geographical center at the very point of its birth.

The rise of modern German ascendancy in Turkey has constituted the gravest menace to the British project of uniting Egypt to India by a broad band of British territory. German diplomacy has exerted its best efforts during the past generation in the attempt to defeat this design. In overcrowded Germany the need of land for colonization is felt as keenly as the necessity of providing new markets for the country's busy industries. Germany does not contain within its frontier an agricultural area of sufficient extent for the requirements of its fast-growing populations. Against this it has been estimated that with adequate irrigation Asia Minor can turn out a million tons of wheat annually as well as at least two hundred thousand tons of cotton. The basis of Teutonic southeasterly expansion lies in these facts. The immediate aim of German imperialism is to spread through Austria and the Balkan Peninsula into Turkey down to the Gulf of Alexandretta and the shallow waters of the Persian Gulf. But its realization implies the shattering of British projects.

This rivalry in the West Asian field became inevitable from the moment that men of German speech became conscious of the power they had acquired in 1870 by banding together in a single state. The task of national consolidation once accomplished, the thought of German leaders naturally turned eastwards in the direction in which land extended. Eight years later the prestige acquired by the newborn empire gave it a decisive voice in the Treaty of Berlin. The first peg in the line of the Teutons' southeasterly march was driven then by the revision of Bulgarian frontiers delimited by the Treaty of San Stefano. The Slavic obstacle seemed removed from the Teutons' path and its place filled by the more easily negotiable Turkish obstruction.

From the date of that treaty to the events of the past year, Germany's conduct in Turkey has been determined entirely by the call of the land. In 1882 a German military commission undertakes to reorganize the Turkish army. In 1889 the Deutsche Bank—whose directors are the real leaders of Germany's oversea affairs—is granted a concession for a through line from Constantinople to Konia. This concession has since been modified so as to comprise the trans-Anatolian trunk railway which connects the capital with Baghdad. In 1898 the Kaiser visits Damascus in person, there solemnly to proclaim assurances of his unalterable good-will to the millions of Mohammedans scattered over the surface of the earth. In 1902 the Baghdad line is definitely awarded to a group of capitalists, among whom Germans represent the majority of investors. Henceforth, railroad, mining, and irrigation concessions in Turkey seemed to have been reserved exclusively for Germans. The transfer of Turkey's unexploited riches to German ownership became almost an accomplished fact.

It was the "Drang nach Osten," a movement directed primarily by the valleys of the Danube and the Morava, and forking out subsequently along the Vardar and Maritza gaps. To clear this road to Turkey Serbia was wiped off the map of Europe in the fall of 1915 by Teutonic armies. For this, too, had Serbian nationality been split into three separate bodies at the behest of Teutonic diplomatists. Bosnia and Herzegovina, lands Serbian in heart and logic, were administered by Austria, an empire in name, like Turkey, but virtually ruled by Prussia since the day of Sandowa. Montenegro, of old the refuge of martyred Serbia, had always been prevented by Austria from uniting with its sister state. In truth Serbia lay under the bane of a geographical curse. It was always in the way.

This misfortune of position is shared fully by Turkey. Coming at right angles to Germany's southeasterly drive, Russia's steady southwesterly advances in the nineteenth century foreshadowed the conversion of the whole Black Sea and its Bosporus entrance into Russian waters. With the most rugged parts of the Armenian massif in Russian hands since 1878, farther expansion through western Armenia into Anatolia cannot be delayed much longer.

The Russian viewpoint deserves every consideration. Russia lies benumbed by the cold of her frozen land. She has had one long winter since the dawn of her nationality. The chief reason why her sons have been laggards in the liberal progress of the past hundred years must be sought in this simple fact of geography. Russia does not need more land or fresh resources. She only seeks the warmth of the sun's rays. Extension of her southern frontiers is forced upon the country, owing to the severity of its climate. Geographically it is Russia rather than Germany who is entitled to "her place under the sun." Individual liberty and democratic institutions will penetrate the country through the portals which genial climate will allow to be maintained wide open.

Russian access to the open sea in the southwest can be secured either by Constantinople or Alexandretta. The Bosporus route is the most advantageous, as the markets for products of the plains of southern Russia are strewn along the coasts of the Mediterranean. But mastery of the Bosporus is of little value to Russia without possession of the Dardanelles strait. The Marmora is but the lobby of the Black Sea. The entire Bosporus-Dardanelles waterway must, therefore, be Russian in order to allow the country to reap the full advantages of attaining ice-free seas. If fifty years ago the question was merely one of political foresight, to-day it has assumed vital importance, for southwestern Russia's economic development in the present century has made the country absolutely dependent on Balkan and Mediterranean markets.

As an alternative, the harbor of Alexandretta finds favor among Russians. It lies at a distance of only 450 miles from the southern Caucasus frontiers. Moreover, it is part of the ancient land of Armenia, which, sooner or later, is destined to become a Russian province in its entirety. Such an extension of Russian territory to blue water on the Mediterranean has significance in two ways. It would redeem a land that has remained Christian in spite of centuries of Mohammedan yoke, and it might effectively bar German access to the Persian Gulf.

Russian influence in Turkey differs signally from the control exerted by its three western competitors. British, German, or French encroachments on Turkish sovereignty have increased in proportion to the amount of capital expended by each of these countries for the development of Turkish resources. In this respect Russia, which is not a financier's country, stood at a disadvantage. To overcome this condition of inferiority Russians resorted to borrowing from France or England, mainly the former, and invested the funds thus obtained in Turkey. Such transactions have in reality been the means of widening French or British influence in Ottoman lands. The northeastern region of Anatolia, which, owing to its contiguity to Russia, was regarded as a sphere of Russian influence, has lately been looked upon often as a zone of French interests, owing to the participation of French capital in its development. But from a geographical standpoint this alleged French zone is artificial. Its dependence on Russia cannot be altered as long as its position on the map remains unchanged.

France's natural sphere of interest in Turkey will be found in the Syrian vilayets. Neither is this due to the financing of Syrian public utilities and industries by French capitalists, as is often stated. The relation is the offspring of the Mediterranean, which since the dawn of history has linked the southern French coast to Syrian harbors. Phoenician oversea trade in the first millenium before the Christian era had attained the coasts of Provence and Languedoc. Marseilles, a city born of this intercourse, has maintained commercial relations with Syria uninterruptedly down to the present time.

Franco-Syrian ties were strengthened considerably during the Crusades. The conquest of Syria and Palestine by the Arabs diverted the thoughts of Christendom from the economic importance of these lands to their religious appeal. France, "the eldest daughter of the Church," took the lead in the attempt to wrest the Holy Land from its Mohammedan conquerors,—"*gesta Dei per Francos.*" Many of the petty states founded by noblemen who took part in the Crusades were ruled by Frenchmen. Antioch and Tripoli had French princes, Jerusalem a French king. The title of "Protector of Oriental Christians" conferred by the Papacy on French kings had its origin in the active part played by France in the Crusades.

France has exercised a dominant intellectual influence in the Levant for at least seven centuries. Turks bestow the appellation of "Frank" on Europeans without discrimination of nationality. Western ideas which have trickled down to Turkish soil are French in character. French schools in Turkey are more numerous than the educational institutions maintained by any other foreign country. The civilizing power of French culture showed its strength by the readiness with which it asserted itself in the midst of uncongenial Turkish thought. France's hold on Turkey thus is of a high moral order. It differs in this respect from the material claims brought forward by the other European powers.

At the same time through the investments of French capitalists a well-defined zone of French interests has been created in Syria. Excepting the Hejaz line, every railroad in the province has been financed in France. The silk factories of the Lebanon, around which the whole industrial life of Syria clusters, have been started by French citizens. Their annual product, usually estimated at half a million kilograms of silk, is exported to France. Syrian silk farmers in need of funds for the annual purchase of cocoons raise their loans exclusively among the banking houses of Lyons. Without, however, confining French interests to Syria alone, it is enough to state that fully one-half of the amount of one billion dollars representing Turkey's official debt to Europe has been advanced by French financial institutions.

[1] William Willcocks: The Irrigation of Mesopotamia, Spon & Chamberlain, New York, 1911, pp. 13-14.

[2] Bushire, with a population of about 20,000 inhabitants, owes its importance to its being the southern sea terminus of the caravan route which starts at Teheran and passes through Isfahan and Shiraz.

It is difficult to assign a place to Italy in the array of European claimants to Turkish territory. The trade between Italian and Turkish seaports has lost the relative importance it had acquired in medieval times. Italian pretensions to Adalia Bay and its rearland are of quite recent date and the result of conquests in Libya. But beyond vaguely formulated promises for railway concessions from the Turkish government no ties bind the region to Italy. The country, however, created its own sphere of interest somewhat unintentionally by the occupation of the islands of the Dodecanesia. It outpaced by this act every other European country taking part in the race for a share of Turkey.

The group of islands lying off the southwestern coast of Anatolia is now held by Italy in virtue of stipulations covenanted with Turkey at the Treaty of Lausanne in 1912. According to the terms agreed upon, Italy was to occupy the Islands in guarantee of Turkish good faith pledged to prevent anti-Italian agitation in Libya. Upon complete pacification of the latest territorial addition to Italy's African domain, the political fate of the islands was to be determined jointly by the six Great European Powers.

The islands, between twelve and fifteen in number, are peopled exclusively by Greeks. Hellenic customs, language, and religion have survived upon each in spite of centuries of Turkish rule. Italian sovereignty, however benevolent or tending to promote the welfare of the islanders, is disliked equally at Patmos, Leros, Cos, or Rhodes. The remaining islands are relatively unimportant, sometimes consisting of mere uninhabited rocks emerging to a height of two or three hundred feet above the Ægean. But, to the smallest inhabited islet, annexation to Greece is keenly desired. The Italians were hailed as liberators from the Turkish oppression by the hardy fishermen, who labored under the impression that their island homes had been rescued in order to be annexed to Greece. Their disappointment was expressed in mass meetings at Patmos and Cos in 1913.

Racial and historical considerations add their burden of proof to the linguistic claims advanced by the Greeks in Greece and the Dodecanesia. As sailors the islanders have maintained to this day classical traditions of Hellenic maritime activity in the region. The islands in fact constitute lands of unredeemed nationality whose natives are without a single exception of the same race as their kinsmen on the mainland.

This fact, combined with the distribution of a numerically preponderant Greek element along the western coast of Anatolia, converts the Ægean into a truly Greek sea. Structurally the coastlands encircling this body of water are identical. In the east as in the west they constitute the upwarped margin of a subsided area. Identity of land and peoples has given rise to the Greek claims on western Turkey. Greece, therefore, stands in line with the other European nations expecting to share in the inheritance of the moribund Turkish state.

The claim is historical no less than economic. The association of the Ægean region with centuries of Hellenism and fully one millenium of Byzantinism is by no means severed in modern days. For the second time in its glorious history, the ancient city of Athens has become the social, political, and intellectual center of the Greek world. In one and the same prospect the Greek capital can point with pride to the Hellenic splendor emanating from Anatolian ruins and to her modern sons achieving daily economic victories over the Turk in his own land.

In this spectacle of nations lying athwart each other's path the clue to the adequate settlement of the Turkish problem may be found. Turkey is above all else a roadway—a bridgeland. The fate of the country is bound to this fact. It cannot avoid it. As soon as this point of practical geography is recognized it will be easy to provide international legislation in which the claims of interested powers will be harmonized. But no solution of the political problem involved can ever be attained without full consideration of its geographical aspects. Omission of the available data of science implies neglect of the realities of the case. It will leave the Eastern question in the hopeless tangle in which it has labored for the past hundred years.

Mechanical Difficulties in the Evolution of the Steam Turbine*

STAGGERED by the mechanical troubles which arose in connection with the development of one of the early designs of dynamos, an American investor is recorded as declaring that he wished he had decided to support a rival type, not realizing that the annoying and expensive incidents were the badge of all the tribe and were merely the inevitable accompaniment of pioneering work of this character. A few years ago agents for steam turbine builders quite frequently attempted to push their own wares by proffering long lists of the mishaps which had overtaken other makes, and from which they asserted their own particular type was immune. The only ground for this assertion, when, if ever, it happened to be true, lay generally only in the novelty of their own wares. "Happy is the country that has no history," and if only a few turbines of a particular type had been built the opportunities for creating a history of misadventures was inevitably lacking. This kind of salesmanship suffered from the drawback that when the new pattern, in its turn, met with misadventures, retaliation was inevitable, and as a consequence many engineers were led to consider the danger of breakdown of any type of steam turbine so serious as to make their adoption impossible, and many large reciprocating sets were installed during these years where the conditions were really such as to make the turbine a much more desirable machine.

In the early days, for example, it was asserted that blade stripping was confined to reaction turbines, with their necessarily small clearances over blade tips. Agents for impulse machines drew attention to the large clearances over blade tips which could be adopted with this type, and claimed, accordingly, complete immunity from this particular evil. Experience, however, soon proved that this proposition was *ben trovato* rather than *vero*, as strips with the earlier impulse turbines were so serious that at the Skodawerke, for example, almost the whole of the profits of the turbine department during the earlier years were swallowed up in replacing blades in turbines which had stripped before being taken over by their purchasers. Much expensive experience had to be paid for before both the design and the material of the blades became satisfactory. This circumstance shows clearly that stripping may result from other causes than small clearances. In fact, in the so-called disk and drum machines it has often been found that the blades of the velocity compounded wheel have been the first to go. This has been the case, at any rate, in power-station practice, where the temperature and the speed of the steam are both high. The matter, no doubt, is mainly a question of design and of materials. The suitability of either is hardly capable of determination by laboratory experiments. It is now ancient history that 25 per cent nickel steel proved a failure wherever used and the A. E. G. have had disastrous experiences with 32 per cent nickel steel even when used for stationary guide-blades. The soft brass alloy which has been so successfully used for Parson's blading has been known to eat away inside of a fortnight when adopted for a velocity-compounded wheel.

A prolific source of blade breakages has been the chance synchronization of the natural periodicity of the blade considered as a vibrating elastic solid, with some periodic impulse either inside or outside the turbine. This was, we believe, first observed with the exhaust blading of the first large steam turbine built by Messrs. Brown, Boveri and Company. In reaction turbines the fixed blades are commonly replaced by solid stoppers, at the joint of the turbine casing. There is thus an interruption, partial or complete, in the supply of steam to a moving blade whenever it passes the joint, and should the periodical time of passing these points agree with the natural period of vibration of the blade, breakage is inevitable. The remedy, which was successfully applied by Messrs. Brown, Boveri and Company to the case mentioned, was to alter the rate of vibration by soldering an additional lacing wire to the blades at mid height. In the case of impulse turbines the use of partial admission stages also introduces a certain periodicity into the forces acting on the blades, and many breakages have been caused in this way. The remedy is, as before, a simple one, viz.: to get rid of this synchronism between the varying force and the vibrator by stiffening the latter. Occasionally, however, this leads to curious results. Certain cases of failure having occurred from causes of this kind, the blades were stiffened by thickening the roots. This proved highly satisfactory until the stiffened blades were used upon a new size and pattern of turbine. With the introduction of this, breakages again appeared, but the blades broke not at the root, but at a point nearly 1 inch higher up.

The earlier turbines worked with saturated or but slightly superheated steam, and the introduction of higher superheats occasioned a plentiful crop of troubles. In the case of reaction turbines these commonly took the form of drums getting loose on their end shafts, due to the unequal expansion by heat of the body of the drum and of the stub connection on to which it was shrunk. This difficulty has long disappeared, owing to suitable modifications in the design. With both impulse and reaction turbines troubles arose through the distortion of the casing, owing generally to some lack of symmetry in the design or inequality in the rate at which heat is convected away from opposite sides. A hot casing will in fact, hog considerably if uncovered. The air currents set up cool the under side more than the top, since they are already hot when they get there. Unequal expansion of this kind was a prolific source of trouble in the early days of the impulse turbines. At the best it meant a bent or broken shaft; while in other cases the trouble was still more serious, as in the case of the cruiser "Mainz," to which turbines were fitted by the A.E.G. In this case the shaft welded itself solid to the diaphragms through which, of course, the clearance had to be very small.

The difficulty arising from small shaft clearances was overcome by adopting Mr. Gerald Stoney's maxim that when one surface is to run at a high speed near another surface and with but a small clearance between, one of the two surfaces must be a mere thin edge. Once stated, the commonsense of this principle appeals to all, and it has been universally adopted by turbine builders the world over. Its discovery was, however, by no means either obvious or easy. Its general adoption has abolished any serious trouble from small clearances, but minor ones still occasionally appear. Two instances are known in which dummy grooves have been washed away by the leakage steam, leaving the metal everywhere fully ¼ inch clear of the opposing dummy strips, for which nickel had been used. No explanation of this extraordinary occurrence has so far been found. Again, although the adoption of Stoney's principle has stopped the breakage of shafts by distortion troubles, the latter are probably responsible for the vibrations still occasionally experienced with two 7,000 kw. A.E.G. turbines. As originally delivered this trouble was so serious that the turbines were unable to take more than one-third of their rated loads, and had to be entirely rebuilt. This enabled them to take their loads if carefully operated.

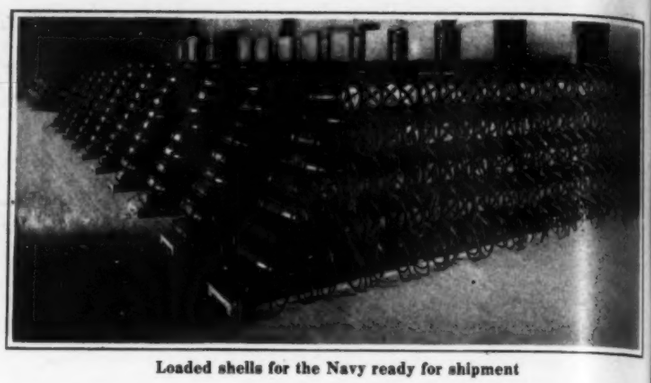
With the increase in the sizes and speeds of turbine wheels another vibration trouble made its appearance. In certain cases, fortunately somewhat rare, the wheel itself begins to vibrate under the influence of certain forces which synchronize with its own periodicity. The periphery takes the form of a standing wave, which remains stationary in space while the wheel itself rotates. The wave consists of a displacement of the rim axially from its normal position when at rest. There are usually four wave-lengths comprised in the complete circumference of the wheel. At four points the crests of the standing wave touch one of the two diaphragms between which the wheel is running, and at four intermediate points the troughs or "negative" crests of the wave touch the other diaphragm. Four points of wear are thus found on each. The result, unless the turbine is at once shut down, is that the rim gets red hot, wears away, and lets the blades out, causing a more or less complete strip. The clearance between the two diaphragms is commonly made as small as practicable, so as to shorten the overall length of the turbine, thus increasing the stiffness of the rotor. For the same reason the wheels are generally made thin, with a consequent reduction in their stiffness.

At one station two machines, both recent productions of the A.E.G., developed this trouble. On opening up one of the turbines it was noted that the offending wheel continued to vibrate in unison with some part of some other machine in the station, so that it appears possible that the trouble may have been started by something quite external to the turbine itself. In any case, the phenomenon is highly erratic. Two machines, both rated at 20,000 kw., were built from the same drawings. The first to be delivered has run without the slightest trouble ever since its erection. The other, while under test in the builder's shops, developed in one of its wheels the standing wave as above described, and had to be, to some extent, reconstructed. Possibly the difference in the behavior of the two machines may be due to slight differences in the rigidity of the joint between the wheel and the shaft. Two forced fits can never be exactly the same, and in the case of the A.E.G. machines already referred to it was found that the vibration was completely cured by clamping to the wheel a weight of a few ounces.

*Engineering.

Analytical Discrimination of Wines.—From an investigation of a number of mistelles (wines made by adding alcohol to unfermented musts) and fermented wines Baragiola and Godet in Z. anal. Chem., conclude that it is impossible to discriminate between the two classes by present analytical methods.

Powder magazines at the Naval Station at Iona Island



Loaded shells for the Navy ready for shipment

A Navy Ammunition Depot

UP the Hudson River, about forty miles from New York, on Iona Island, is located the principal navy magazine, where ammunition for the vessels of the United States navy is stored and prepared for use. This was established a number of years ago, and while the establishment has been of ample size for all requirements during times of peace it would not in its present condition begin to meet the demands of active war operations, although the 116 acres of the island affords room for quite extensive enlargement.

The plant now existing at Iona Island comprises a number of solidly constructed buildings for the storage of powder, together with several structures of a lighter character where shells are loaded with their exploding charges, and where the cartridges for firing the shells are put up. These latter are in the form of cloth bags, which are made upon the island in an establishment greatly resembling an ordinary tailoring shop. The bottoms of the bags are cut out by dies under a power press, while the sides are cut, many thicknesses at a time, by electric cutters, similar to those employed by tailors for cutting out clothing. After the material has been cut up, the parts, together with the bands used for binding up the bags, are joined together by sewing machines. These operations are shown in one of the illustrations.

One of the pictures shows samples of the ordinary kind of smokeless powder used for charging large guns. It will be seen that the powder is in the form of small cylinders, which are pierced from end to end by a number of small holes, and the purpose of this arrangement is to produce the proper kind of explosion in the gun. If the explosion was instantaneous, like that of nitroglycerine, the shock would be so sudden as to rupture the gun, even before the shot could be started on its way; but with this form of powder the explosion is of the nature of an extremely rapid burning, thus producing a progressively increasing gas pressure that starts the shot gradually and continues to accelerate its speed until it leaves the muzzle of the gun. The nature of this explosive burning is as follows: A cylinder of this form cannot be exploded instantaneously, but the flame from the priming ignites the cylinder both on its outer surface and through the small holes at the same time. As the cylinder burns the holes become larger, thus affording a continually greater burning surface, and the production of gas increases proportionately. The result of the total action of hundreds of these small cylinders of compressed powder is that the pressure is comparatively low at first, thus starting the movement of the heavy shot without an injurious shock to the gun, but the pressure rapidly increases and progressively increases the speed of the projectile.

As considerable weights of material have to be transported about the island a little railroad has been laid out extending from the dock on the river to the various buildings, but as an ordinary steam locomotive would be dangerous, on account of the possibility of sparks coming from it, a special motor operated by compressed air is used.

The accompanying illustrations show several of the buildings, and a section of one of the storage houses where shells for our battleships are piled up ready for instant delivery.

Analysis of Vocal Sounds Made by Singers

THE human voice has been compared by Savart to the instrument known as a bird-call, but as was recently pointed out by M. Marage, in an address before the French Society of Physics, it resembles in reality no known instrument, since it has the unique property of changing its form at each vowel and each note uttered. This well-known authority has recently concluded some important studies of the human larynx during the act of singing, from which he has obtained the following information, presented to the above society on November 17:

When we take a tracing of the curved line which represents a sung vowel, we observe that the tracing varies with each note, and that the lower the note the more complex the grouping. This holds true whatever may be the method employed for procuring a tracing of the vibrations. If, on the contrary, we take a tracing of the spoken vowel we obtain curves much more simple and peculiar to each vowel.

The vowels *I* (English *ee*) and *OU* (English *oo*) have groupings characterized by a single period; *E* and *O* (English *A* as in Ache and *O* as in hope) by two periods; and *A* (English *a* as in *Ah*) by three periods. These tracings, which are very simple, cannot be considered as exact unless, starting from the results they give, we can make the synthesis of the five fundamental vowels. This is accomplished by means of a siren composed of five disks whose parallel axes are set in motion by an electric motor.

The vowles *I* and *Ou* are represented by equal and equidistant apertures, the vowels *E* and *O* by groups of two apertures, the vowel *A* by groups of three apertures. These apertures are triangle for *OU, O, A;* for *I* and *E* they are narrow with parallel edges; the form of the glottis when giving the vowel is thus imitated. The fundamental note is given by the number of groups. The air pressure is measureed by a metallic manometer graduated from 0 to 200 millimeters of water, the air pressure in the lungs varying within the same limits.

This instrument reproduces the five vowels; they are recognized perfectly by the ear, and moreover the tracings of these synthetic vowels are the same as those of natural vowels. They remain the same whatever the fundamental note may be. The *timbre* of the synthetic vowels is therefore the same as that of the natural vowels. The *height* of the sound emitted by the siren comprises all the vibrations which can make an impression upon the ear, from the lowest sounds (do-2) which we do not hear, since it is less than sixteen vibrations, to the most shrill, which cease to be perceptible (*do* 10, 33,400 vibrations). The sounds uttered by the siren comprise therefore the *tessitures* of the human voice, which runs from *fa* 1 to *fa* 4.

The *intensity of the sound*, or rather its energy, is represented by the volume of the air *V* which passes into the siren with a pressure *H*. But a natural vowel is produced by 4 liters of air at most, under a pressure of 200 millimeters of water. To reproduce these synthetic vowels we have at our disposal 30 liters of air under pressures varying from 0 to 200 millimeters of water. We can therefore produce synthetic vowels as faint and as intense as those of the natural voice.

The apparatus, therefore, reproduces the natural vowels from the three-fold point of view of timbre, of pitch, and of intensity.

It now remains to explain why, in vowels which are sung, the tracing of the same vowel varies with each note, and increases in complexity as the note becomes lower. For this purpose we place upon the siren a model of the mouth while it is pronouncing *a*, and take the tracing while causing the note to vary; we observe that, as in the natural vowels, the lower the note the more complex the tracing, and the tracing of the synthetic vowels when sung is similar to that of the natural vowels when sung. The results are analogous if we replace the model of *A* by those of *O* and *OU*. Subsequently we can let the note remain constant while varying the form of the mouth by taking rubber models of it; finally we can vary the note and the form of the mouth at the same time. Since, moreover, we can reproduce the five vowels with the larynx alone, the buccal resonator being encircled by the teeth, and since the larynx of a dog, isolated, can reproduce the vowels alone, we have the right to make the following conclusions: 1. It is the *ensemble* of the larynx (inferior vocal cords, ventricles of Morgagni, and superior vocal cords) which constitutes the instrument which Savart compared to a bird-call, but which really resembles no known instrument, since it changes its form with each vowel and each note; 2. The five fundamental vowels are due to an intermittent aero-laryngian vibration *reinforced* or *transformed* by the buccal cavity—*reinforced*, if the mouth has taken the form which it should have and which varies with each note and each vowel; *transformed*, in the contrary case, and able to give birth to other vowels; this is why we are able to comprehend only those singers who give the desired form to the mouth. Since all larynxes resemble each other and are differentiated only by their *tessitures*, the laryngian vowels are found in all languages, and this is the reason they are termed *fundamentals*.

Engines for Cargo Boats

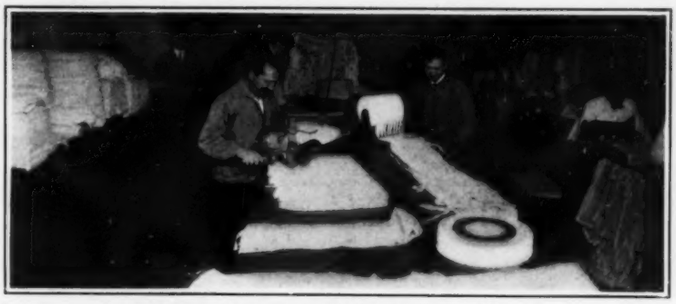
IN the hope that it will prove beneficial not only in securing the maximum rate of progress in technical advance, but also in promoting convenience and dispatch in the purely business sphere, the Council of the North-East Coast Institution of Engineers and Shipbuilders presented a guidance specification for reciprocating triple-expansion engines intended for cargo boats of moderate speed for general trade at a recent meeting.

In preparing the specification the best practice of the day and the district was taken as the basis, the object in view being the ultimate standardization of parts. Any intention of changing accepted and successful practice is disclaimed, the purpose being merely to reduce that practice to a common basis and to add to it when desirable or necessary in order to raise performance to the highest pitch of efficiency. It is contemplated to keep the specification thoroughly up to date by annual revision, and it is hoped that ultimately it may be extended to include not only the main engine proportions and scantlings, but also the boilers, auxiliaries, and other details. Quadruple-expansion engines, geared turbines, and internal combustion engines will be dealt with as time permits.

In addition to calculations and formulæ referring to different parts of the engines, the specification contains some notes or suggestions on points of design and equipment likely to conduce to efficiency. One of these is to the effect that when a steam jet is employed for the extraction of air and a suitable design of condenser is employed, the greatly increased efficiency of the condensing surface enables a higher temperature of feed to be obtained and the sizes of air pump and circulating pump for a given vacuum to be considerably reduced, thereby saving pumping power and total weight. This clause has been criticized on the ground of being put forward for purposes of business propaganda. But the patent which Sir Charles Parsons, who discovered the merits of a steam jet as an air extractor in 1902, took out in the same year, lapsed at the end of 1916, and according to Mr. D. B. Morison, who some years ago made investigations on the steam jet as a means of producing very high vacuum and last year discovered its advantages as an economical producer of low vacuum, there is no apparatus known to engineering which will raise the steam efficiency, the power efficiency, and the weight efficiency of an ordinary low vacuum marine engine as will a steam jet. He asserts further that a cylindrical condenser of the ordinary type, coupled to an Edwards air pump in the ordinary manner, represents relatively the lowest efficiency in steam economy, power and weight.—*London Times, Engineering Supplement.*

The Freezing Point of Mercury.—The Bureau of Standards, by means of resistance thermometers, taking precautions to avoid various possible errors, has determined the mean value of the freezing point of mercury to be 638.873°C.

Smokeless powder as prepared for use in big guns



Making cartridge bags to hold the charges of big guns

The Minimum Radiation Visually Perceptible

By Henry Norris Russell, Princeton University

In a recent paper[1] Ives has shown that the least quantity of radiant energy capable of producing the sensation of light is much smaller than had previously been supposed, the error of the earlier estimates arising from the treatment of all radiations within the visible spectrum as if they were equally efficient in producing the sensation of light, which is extremely far from the truth. The numerical results given in his paper depend, however, upon four factors, two of which were well determined, while the other two could be but roughly estimated in the absence of sufficient data. It is the purpose of the present communication to supplement Dr. Ives's work by the introduction of improved values for these latter factors, derived partly from material inaccessible to him and partly from unpublished observations.

The well-determined factors are the mechanical equivalent of light and the stellar magnitude of the standard candle. The former may be taken as 1.59 ergs per second per square centimeter,[2] for light of intensity one meter-candle, and wave-length 0.55 μ (corresponding to the maximum visual sensation for equal energy). The meter-candle, according to the mean of several fairly accordant determinations,[3] is of stellar magnitude—14.18. It follows that a source emitting light of wave-length 0.55 μ, and appearing like a star of magnitude 6.0, would furnish energy at the rate of 1.35×10^{-8} ergs per second per centimeter. These data are taken unchanged from Ives's discussion.

The uncertain factors are the diameter of the pupil of the eye when accommodated to complete darkness, and the stellar magnitude of the faintest visible objects.

Upon the first of these points the only really reliable information appears to be contained in a brief paper by W. H. Steavenson[4] which reached this country just after Dr. Ives's paper was written. Measurements were made by photographing the eyes, accommodated to complete darkness, by flashlight, since the presence of light strong enough to permit of direct measurement caused a decided contraction of the pupil. The mean diameter for five healthy men was found, under these conditions, to be 0.336 inch, or 8.5 mm, with an average deviation from the mean of only 3 per cent. This makes the area of the pupil 0.57 sq. cm—just double the value resulting from Ives's estimate of diameter 6 mm, and nearly three times that derived from the conventional figure of "one-fifth of an inch."

More important is the second question. There is abundant evidence to show that the visibility of faint stars is greatly affected by the diffused light of the sky. How great this influence is, even for the brighter stars, is often accidentally illustrated when a star happens to be seen through a gap in the foliage of a tree, upon a relatively dark background. To the writer, at least, it appears so much brighter than usual under these circumstances as to make immediate identification difficult.

A very valuable series of observations of the visibility of stars upon a dark background has been made by H. D. Curtis.[5] Faint stars were observed through a small hole in a large screen attached to the remoter end of the 12-inch telescope, and the reality of the observation was controlled with the telescope. Though the faintest star seen directly upon the background of the sky was of magnitude 6.53, stars of magnitude 7.2–7.4 were easily seen upon the dark background, four others of magnitudes between 7.9 and 8.1 were usually seen with little difficulty, two of magnitude 8.3 were "seen with difficulty," and a star of magnitude 8.9 was "glimpsed at intervals, very doubtful." It appears, therefore, that if seen upon a perfectly dark background the limit of visibility for a stellar point must not be far from the magnitude 8.5—especially when it is remembered that the dome of an observatory, under ordinary working conditions, is by no means perfectly dark, even in the absence of artificial lights.

Further evidence bearing upon this matter is found in certain observations by the writer, part of which have been published.[6] If a room is completely darkened except for a small part of one window, less than a square foot in area, and the light of a star, shining through this aperture, is received on a white screen on the opposite side of the room the faint luminous patch may be easily observed if the eye has become thoroughly accommodated to darkness. The light of the first-magnitude stars is unmistakable, and that of Sirius really conspicuous; but in this connection the following transcript from the notebook is of interest. "Sky near Sirius much brighter than paper illuminated by Sirius-light, so much so that it dazzles the eye, appearing as a dark spot on the Sirius-lit paper, after a glance at the window. To see the fainter lights to advantage, it is necessary to remain in the dark for at least half an hour, and to avoid looking at anything as bright as Sirius-light for a few minutes before observing." Under favorable conditions, the illumination of the paper by stars fainter than the second magnitude was recognized, the faintest stars whose light was certainly identified being of magnitudes 2.8 and 2.9. As these stars were at a moderate altitude, it is probable that the illumination of a white surface by a star of the third magnitude in the zenith would be distinctly perceptible.

The following observations, which have not previously been published, are copied from the notes written at the time:

February 8, 1902. Investigations on *minimum visible*. Two approximately circular disks of white cardboard were pinned on black cloth, and the greatest distances at which they could be seen, when illuminated by starlight, marked with pins on a tape measure. Disk A (larger) maximum distance, light from Sirius, 39 inches
Disk B (small) maximum distance, light from Sirius, 20½ inches
Disk A, light from Rigel, maximum distance 16½ inches. The disks lost all definite outline at less than half these distances and appeared as faint, ill-defined luminous spots, like the old luminous match-safes. Diameter of Disk A, 0.45 inch, of Disk B, 0.80 inch.

From these data the *minimum visible* may be calculated in terms of stellar magnitude as follows. The disks were illuminated and viewed nearly at right angles to their own plane. If the radius of the disk is r, the distance of the observer's eye R, and if it is assumed that the disk reflects diffusely the fraction A of the incident light, in accordance with Lambert's law, the light received by the eye from the disk should be to that received directly from the star in the ratio $A\frac{r^2}{R^2}$:1, to which corresponds a difference of magnitude amounting to 5 log R/r—2.5 log A. If the value of A for the white cardboard is taken roughly as 0.8, the last term is $\times0.25$, and the three observations give (correcting the obvious interchange of A and B at the end of the original note):

Star	Disk	Mag. of Star	R	r	5 log R/r	*Minimum Visible*
Sirius	A	−1.58	39	0.40	9.95	8^M6
Sirius	B	−1.58	20.5	0.225	9.80	8 5
Rigel	A	+0.34	16 5	0.40	7.95	8 5

The observations, which from the nature of the measures must have been quite independent, agree better than might have been expected. The resulting *minimum visible*, 8^M5, is in entire agreement with that found by the Lick observers, and is ten times fainter than the ordinarily assumed limit for the visibility of a star against the relatively brilliant background of the sky.

The amount of energy which would enter the eye from a light-source of maximum efficiency, and of magnitude 8.5 is, according to the foregoing, $1.25\times10^{-8}\times0.57\times0.10$, or 7.7×10^{-10} ergs per second—which may be taken as the best available approximation to the true *minimum visible*. This is just one-fifth of the value found by Dr. Ives, as follows at once from the facts that the values here assumed for the area of the pupil and the faintest visible light are respectively twice and one-tenth of those adopted by him.

The faintest visible illumination of a surface (by a third-magnitude star) corresponds to 1.3×10^{-7} meter-candles, and, for light of the maximum efficiency, to an energy-density of 2.1×10^{-7} ergs per square centimeter per second. Since there must be some losses, both on reflection at the surface and in passing through the eye, it follows that a sensible stimulation of the retina can be produced by an energy-density less than 2×10^{-7} ergs per square centimeter per second at the surface of the retina itself, provided that this stimulus is applied over a sufficiently large area (which, to make the incident energy equal to the minimum previously given, must have an apparent angular diameter of at least 10°). Ten times this illumination, corresponding to the light of a star of magnitude 0.5, is conspicuous to the fully rested eye, so that the "shadow bands" caused by the irregularities of density in the earth's atmosphere can be seen on the screen under favorable conditions.

The results here given are subject to possible corrections for the difference in area of the luminosity-curve for high and low intensity, but Dr. Ives has shown that these are probably small. The greatest outstanding uncertainty is that of the observational determinations of the *minimum visible*. According to the present estimate, the minimum perceptible radiation corresponds to the reception by the eye of about 200 elementary quanta of radiation per second, or, in ordinary units, of *one erg in forty years*, or one gram-calorie in 1,700 million years.

Further investigations of this question by laboratory methods would be of great interest, especially if an attempt was made to determine how long a time was required for such very faint light to produce a perceptible sensation.

Sugar Cultivation in Ceylon

Ceylon is a country which offers a good outlook as concerns sugar production, but it is certain that the present attempts at cane cultivation must be amended in order to secure the results which we are entitled to expect. Such cultivation was carried out in the past period on the lines followed for growing cocoanuts and rubber. It is observed, however, that a sugar-cane crop can not be left to itself, and the mechanical condition of the soil is of the greatest importance to the shallow root system of sugar-cane, and an intensive cultivation is essential. In districts of heavy and constant rainfall in Ceylon, rubber and cocoanuts are preferred to sugar, and for this reason it is on irrigable land that sugar cultivation must be pursued, and in fact there are large tracts of irrigable land available. In such cultivation the growth of the sugar-cane must be constantly forced from the beginning until it is ready to ripen, and an unrestricted supply of water must be available as will as strong sunshine. In Ceylon Labor is cheap, and the cost of sugar manufacture is estimated at $20 per ton.

Aeroplane Ambulance Work

Illustrative of what aeroplanes can be called on to do in the way of ambulance work, the review *Paris Médical* cites the following unusual exploit carried out by French aviators. During the retreat of the Serbian army, which was carried out under very trying circumstances, a group of French flyers, which was attached to this army, succeeded in accomplishing a feat which is of rare occurrence. The aviators had at their disposal but a small number of two-place flyers, but were able to transport wounded soldiers to the extent of a dozen or more, working between Prisrend and Metrovitza and even as far as Vallona. This was done under unusually hard conditions as concerns temperature, state of the atmosphere and of the ground, and is of interest at least from the novelty of the proceeding.

[1] *The Astrophysical Journal*, Vol. XILV, No. 1.
[2] *Astrophysical Journal*, 44, 124, 1916.
[3] Ives, Coblentz, and Kingsbury, *Physical Review*, 5, 269, and 6, 319, 1915.
[4] Russell, *Astrophysical Journal*, 43, 129, 1916.
[5] *Journal of the British Astronomical Association*, 26, 303, 1916.
[6] *Lick Observatory Bulletin*, 2, 67, 1901. The magnitudes of some of the stars have been replaced by more recent Harvard photometric determinations.

[6] "Shadows Cast by Starlight," *Popular Astronomy*, 10, 242, 1902.

The Silver Voltameter as An International Standard for the Measurement of Electric Current*

By E. B. Rosa and G. W. Vinal, U. S. Bureau of Standards, Washington, D. C.

THE International Electrical Conference which met in London in 1908 adopted the ampere as the second fundamental electrical unit, the ohm being the first, and defined the international ampere in terms of the electrolytic deposit of silver in the silver voltameter. At the time of this conference it was the opinion of the delegates from this country that the volt should have been chosen in place of the ampere, because the standard cell was more reproducible than the silver voltameter and was the means then as now actually employed (in conjunction with the ohm) for measuring the ampere by the drop in potential method. The decision of the conference was, however, accepted as final, and researches were undertaken in several different countries, and particularly in this country, with the aim of making the voltmeter worthy to bear the responsibility imposed upon it by the London Conference. The purpose of this paper is to give briefly the most important results that have been obtained and to show the remarkable agreement of the measurements recently made in the national laboratories of several different countries of the electromotive force of a Weston normal cell, in terms of the international volt as officially defined. This agreement is due to the fact that great advances have been made in our knowledge of the silver voltameter in recent years; and although no adequate specifications have been formally adopted, the methods followed by recent investigators have agreed in essential particulars, although differing in details.

No concrete standard for the ampere, corresponding to the column of mercury for the ohm or the standard cell for the volt, is possible. The value of an electric current may, however, be conveniently expressed for the purposes of precise measurement in two ways. Either the silver voltameter may be used to calibrate an ampere balance as was done by the British Board of Trade, or the voltage of the Weston normal cell may be determined when a measured current passes through a known resistance. The latter method was adopted by the London Conference, but at that time information was lacking as to the proper value to assign to this cell, which was adopted by the conference in place of the Clark cell.

In 1910 a committee consisting of representatives of the National Laboratories of England, France, Germany, and the United States met in Washington and made careful voltameter measurements to determine the voltage of the Weston normal cell, in the manner agreed upon at London in 1908. The Committee found the value to be very nearly 1.0183 volts at 20° C. This value, recommended by the Committee as the international value of the Weston normal cell, has become the basis of measurement in general use for voltage and (with a resistance) for current measurements also. Although the cell has thus become the practical standard, the voltameter has not lost its importance, for it is the ultimate standard which is to be depended upon in the future to determine whether the standard cells preserved by the various national laboratories are maintaining an unchanging voltage.

The researches on the voltameter which have been made since the international technical committee adjourned have been in part for the purpose of finding out with greater precision (to the sixth significant figure) how close the value for the cell as computed from the voltameter results and the international ohm is to the value 1.0183 volts adopted by the Committee. Although the difference is inappreciable for most purposes, it is desirable that it be determined as accurately as possible. It is also very necessary to have adequate specifications for the voltameter that shall enable us to obtain results in the future comparable with those obtained now. In this work the Bureau of Standards has been able to take an active part. Many sources of error in the voltameter have been discovered and means for their elimination provided, and the voltameter may now be considered capable of being used to check the voltage of the Weston normal cell.

During the course of the work differences of opinion have arisen among some of the investigators in this and other countries, but by co-operative experiments and correspondence practically all of these differences have been settled so that at present, we believe no important questions are still outstanding. A few of the most important developments during the recent voltameter work may be mentioned.

It was well known before the Bureau of Standards began its work that the deposits in the Rayleigh or filter-paper form of voltameter exceeded those in the porous cup voltameters which were used in series with them. No satisfactory explanation of this difference had been given, and its existence had indeed been questioned. The most recent investigation prior to the London Conference appeared to show that under certain conditions the two forms of voltameter agreed. It was discovered at the Bureau of Standards that the difference could be doubled if the amount of filter paper was doubled and that when the filter paper was wrapped around the porous cup the results were the same as if the porous cup were not present. In short, it was definitely proved that the filter-paper itself was a source of serious error in the voltameter. A chemical study showed that the cellulose fibers of the filter paper are slightly oxidized in the air and the minute amounts of oxycellulose are soluble in water. These give rise to strong reducing agents in silver nitrate solutions and colloidal silver is formed. The colloidal particles carry electrical charges much smaller proportionally to their mass than do the univalent silver ions and therefore give rise to deposits in excess of the true deposit according to Faraday's law. They also alter the form and appearance of the deposit.

Methods have been developed at the Bureau for the preparation and testing of silver nitrate of the exceptional purity which is necessary for voltameter's work, because very minute impurities produce exaggerated effects in the voltameter deposits. All forms of voltameter (except the filter paper form and forms using linen, cotton, silk, etc., as a septum) are in substantial agreement when used with solutions of the highest purity and with proper precautions against anode slime. The temperature coefficient with pure solutions was shown to be zero as it ought to be. The precaution taken by some observers to soak the silver deposits over night in distilled water to remove the last traces of electrolyte was shown to be harmful because it was discovered that silver in contact with platinum is appreciably soluble in distilled water. This was shown by repeated tests. The silver and the platinum differ slightly in potential so that a current passes from the silver to the platinum through the water. Although this current is very small, it was demonstrated by a sensitive galvanometer and the loss of silver from the deposit was measured.

Another discovery of importance is the alloying effect of the silver and platinum when determining the inclusions of foreign matter in the deposits by the method of heating. After the slight alloying has taken place, the removal of the silver leaves a very thin layer of platinum black on the inside surface of the cup. Unless this is entirely removed its absorptive properties make the weight of the cup uncertain and its catalytic properties cause the deposition of hydrogen ions when another silver deposit is made so that the amount of silver is not a true measure of the electricity according to Faraday's law.

Various observers in different countries by avoiding these sources of error have obtained very concordant results as the following table shows:

TABLE I
VALUES FOR THE WESTON NORMAL CELL AT 20°C. COMPUTED FROM SILVER VOLTAMETER MEASUREMENTS

COUNTRY*	FORM OF VOLTAMETER†	VALUE FOR CELL	Δ
			parts in 100 000
United States	Smith	1.01827,	−0₅
United States	Richards	1.01825,	−0₅
Japan	Smith	1.01826,	−0₅
Russia‡	Smith	1.01829,	+1₅
Holland	Smith	1.01826	−1₅
Germany	Kohlrausch	1.01829,	+1₅
Mean		1.01827,	+1₅

*England and France have not published any measurements of this kind since the time of the International Committee. The Observers are: for Japan, Obata; for the U. S., Rosa, Vinal, and McDaniel; for Russia, Mlle. Ferringer; for Holland, Haga and Boerema; for Germany, von Steinwehr.

†The Smith form and the Kohlrausch form are similar in principle. They have no separation between anode and cathode except a glass trap to catch the anode slime, but the construction of this trap is very different in the two forms. The Richards form makes use of a porous cup septum.

‡This is the mean of four sets of measurements on a particular cell at different periods during several years.

The average deviation from the mean result is only 0.001%. The experimental error involves the errors of both the cell and the standard resistance as well as the numerous sources of error in the voltameter itself. These include the errors of weighing the bowls both before and after the deposit, the errors of timing the deposits, the errors due to fluctuation in the current, and the errors in washing and drying the deposits. In view of these it is remarkable how small the deviations are for the individual countries. Those results are the work of investigators of five nationalities using three different types of instruments, and yet they agree to about 1 part in 100,000.

The national laboratories were in correspondence on the matter of specifications when the war in Europe began. Since then the Bureau of Standards has prepared and published its specifications for the voltameter and it will recommend these for adoption when it is again possible to do so after the restoration of peace.

The specifications which the Bureau of Standards has formulated have been made as broad as is consistent with work of the highest accuracy. They do not specify any particular form of voltameter, but rather the conditions which must be fulfilled by the voltameter. The concentration of the solution is given rather wide limits because it has been found that identical results may be obtained with pure solutions over a considerable range.

An important question as to the purity of the silver obtained has only recently been settled. The impurities are very small, as indeed previous observers, including Van Dijk in Holland, Jaeger and von Steinwehr in Germany, and Boltzmann in Austria, have previously shown. The Bureau of Standards has found the average amount of foreign matter in its standard deposits to be about 0.004%. It is so uniform in the different deposits that the results given by the voltameter as a measuring standard are sufficiently accurate without the necessity of determining the foreign matter in each individual deposit. Without the greatest precautions the error introduced in attempting to determine the inclusions will be greater than the total amount of the inclusions.

In some of the experiments at the Bureau of Standards our absolute current balance has been used in connection with the silver voltameter. This has permitted the determination of the absolute electrochemical equivalent of silver. It was found to be 1.11804 mg. per coulomb, but when corrected for the inclusion of foreign material this becomes 1.11800 mg. This figure is exactly the value assigned to this constant, although at the time it was adopted by the London Conference, eight years ago, the best information available indicated a higher value by about 30 parts in 100,000. In Holland, Prof. Haga, has obtained 1.11802 using a tangent galvanometer. We believe that the closest figure that can be assigned at the present time to this constant is the round number 1.11800 mg. per absolute coulomb, and is this precisely the value fixed by international agreement in "international coulombs."

Since one absolute coulomb of electricity deposits 0.00'11800 gram of silver, the number required to deposit a gram-equivalent of silver, 107.88 grams, is 96,494 coulombs, which is the value of the Faraday. For general use the value 96,500 coulombs is a convenient round number which is within the experimental error.

Although some phenomena of the voltameter are not yet perfectly understood, the recent researches have shown how to use it as a reliable current standard and as a means of checking the constancy of the value of the Weston normal cell. The experiments made at the Bureau of Standards during the past eight years have been fully described in a series of papers which have appeared in the *Bulletin* of the Bureau.

*A paper read before the National Academy of Science, and republished from the *Proceedings*

Who Are the Sane?

IF the definition of insanity was followed to the letter, were experts appointed to examine all men, few would escape the brand of insanity, but who could qualify as an expert since we may become insane upon the subject of insanity? All have their predilections and prejudices, symptoms of a mild form of mental bias, passing under the ambiguous name of eccentricities; and some there are, so erratic that we should call them insane did they not possess sufficient sanity to dissemble their weakness.—C. E. WARREN, *Medical Fortnightly*.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

A New Cipher

Editor SCIENTIFIC AMERICAN SUPPLEMENT:

I was surprised to note in a recent number of the SCIENTIFIC AMERICAN reference to "A New Cipher." The article was reprinted from the Proceedings of the Society of Engineers of Philadelphia and referred to the "cipher" in question as being unintelligible to any save those possessing the key word or words. It also referred to the cipher as a new one and stated that it is the one in use in the United States Army—all of which statements are incorrect and misleading. It is believed, however, that the author of the article was entirely honest in his opinions and that his statements were made in good faith for it is an error the inexperienced invariably make in assuming a cipher which is new to them or which appears difficult or even impossible of solution is really as new and impossible of solution.

The very day I read the article in question I wrote the Secretary of the Club in question asking that the author of the article send me a message enciphered by the use of the system under discussion consisting of 50 to 100 words, offering, in return, to give him the plain text of his message as well as tell him some interesting facts concerning the cipher under discussion. Up to date I have not had a reply.

In March 3d number I note an article by Lieut. Borden, Corps of Engineers, U. S. Army in which he expresses surprise that the author of the first article should take the cipher already mentioned so seriously and suggesting in its place the Playfair cipher.

The Playfair cipher, as Lieut. Borden states, is really a good military cipher and is the one adopted by the British army as their field cipher. It is easy to encipher and decipher when the key words or words are known and very difficult to decipher otherwise, which after all, are all the essentials of a military field cipher. Lieut. Borden did not state that the cipher was "undecipherable" without the aid of the key for, although difficult, the Playfair yields to treatment at the hands of an expert the same as all other systems although considerably more difficult of solution than most others.

The cipher referred to in January 27th SCIENTIFIC AMERICAN as new is the old Vinegere cipher of the sixteenth century; it is also known as the "Alphabetical Square" and also known as the "Russian Square." To the uninitiated it is formidable in the extreme but offers no great difficulty of solution to one experienced in cipher work.

I think I am correct in stating, and I believe that those who know will bear out my statement, that there is no such thing as a really "undecipherable cipher." What is meant by that is a cipher that will not yield up the information it contains without the key word. There are some complicated ciphers in which complicated machines figure but these may be ignored for military purposes as the requirements of the latter service requires a cipher that is not complicated and that requires no complicated apparatus in its use and that will avail the enemy little or nothing in event of its capture. At best all a military commander can expect from a cipher is that it will render his dispositions secure for a time at least, and all he can hope for is a cipher that will so delay the enemy in deciphering as to render its possession by the latter of no benefit.

A discussion of the matter of "ciphers" would, I am sure, be most interesting and instructive and it is barely possible that some new ideas might be brought out thereby.

I trust you will find space for this in your valuable publication.

OTTO HOLSTEIN,
Captain, Field Co. B,
Kentucky Signal Corps.

Platinum as a Gel or Colloid in the Rocks of the Pacific Coast

Editor SCIENTIFIC AMERICAN SUPPLEMENT:

SUMMARY OF THE EVIDENCE

Foreword: From a careful personal investigation made of the patinic-bearing rocks of the North American Pacific Coast, in re PLATINUM, my findings of Facts are as follows:

1.—The ancient metamorphic river deposits of the fragmentary rocks and granulated silts, and also the ancient sea beaches and coastal floors of the Pacific Coast of North America, contain in their cementing materials considerable quantities of gold, and platinum, as well as other rare metals, but not in the usual form of either a crystalline "mineral" or as a "metal."

2.—The said platinum rocks, or platinic ores, seem to be a mixture of crystals and fragments of peridotite, pyroxene, feldspar, quartz, slate and schist, which are compactly cemented together by a form of argillaceous or clayey ferric oxide, into a rock of a more or less indefinite hardness, character and composition, and with many definite indications of a marine origin. And, where such rocks have been fused together into a densely grained mass, by either volcanic heat or by seismic action, or by both causes, they then become very difficult of proper nomenclature and classification.

3.—The "cementing" material or binding compound of this class of platinum bearing rocks, appears usually only as an iron-bearing clay, but some times is found in the state of very finely divided crystals of silica—*i. e.*, crushed quartz—and also as a graphitic or carbonaceous lamellar compound resembling graphite.

4.—This platinum in these rocks does not exist either as a metal or as a mineral, but is always found in the genetic condition which precedes the formation of a true crystalline "mineral," that is, in the form of a Gel, *i. e.*, in a "colloidal" condition of such extremely fine division, that only the power of an ultra-microscope can cause it to be optically visible, and has rarely been found to be larger than a mass of matter requiring the power of 2,500 diameters to be separated so as to be distinctly optically visible.

5.—This platinum, does not seem to exist in the crystalline structure of these rocks, but is generally found in the cementing material, whether it be loosely compacted, or whether it be fused together as a "rock."

6.—This platinum thus being *not* in any crystalline form as a mineral or as a metal, cannot be acted upon immediately and definitely by any of the analytical reactions or chemical affinities which are now known to the science of chemistry. And this is practically the chief reason why the most widely and exceedingly exasperating divergent results have been obtained by the ordinary methods of chemical analysis employed by highly trained chemical analysts for platinum, who from the same sample of "pulp" obtained the most extraordinary divergent results from, nil—trace—0.50 oz. to 69 ozs.

7.—The platinum, being rarely in larger quantity in the rock than as 1 to 64,000 (or as an 0.50 oz. to the ton of rock) and of such almost incredible fineness of division and also being extremely irregularly distributed throughout the rock mass, it becomes a physical impossibility to "average" the form of chemical method or number of "assays" the same identical *pulp sample* given to ten different analysts.

8.—The platinum in these rocks, can, however, be converted into a crystalline state by a form of oxidation produced by intense heat and then is in a condition that while no accurate average of *assay results* can ever be expected to be obtained—on account of the irregularity of the deposition of these extremely finely divided *needle-points* of platinum scattered amongst the cementing material of the rock mass—yet, from a commercial and practical point of view, the entire platinic content of the crushed rock-mass can economically be obtained.

9.—It must be understood, however, that no class of assay of these platinic rocks can be of any practical value, unless a sample of not smaller than one ton of pulp is used, and not less than 300 mesh fine.

10.—There are several methods which I have found will give quite satisfactory results as to the commercial extraction of the platinum, and some of these methods I herein cite as follows:

11.—The rock should be crushed to a mesh of at least 300 fine, and by radiated heat in a current of oxygen added to air, brought to a state of incandescence, which seems to instantly convert the non-crystalline or the colloidal condition into a mineral or true-crystalline condition, and if then passed through a vertical bath of incandescent molten lead (in a vacuum chamber to prevent rapid oxidation of the lead) containing 5 ounces of silver to each ounce of platinum in the rock, and then thereafter expelled in the usual manner, the lead can be recovered as plumbic oxide, and the silver recovered again as metal, and the Platinum obtained as a platinic "sponge" or platinum black, which can be alternately heated and rammed until it becomes dense, metallic platinum, in the *metal* state.

12.—This sintered and calcined dust can be coated to about scalding heat or about 80° C. and then ground in a closed iron container in a bath of mercury covered with an aqueous mixture of 10 per cent of caustic ammonic hydroxide with 90 per cent of water, which will then quickly electro-chemically amalgamate the platinum with the mercury and this "platinic" content thereafter can be separated from the mercury by the usual commercial forms of retortation similar to what are now used in the separation of gold from any auric-mercuric amalgam in gold metallurgy.

DR. WILLIS EUGENE EVERETTE.

Cleansing the Nose and Throat

THE truth about "antiseptics" is very little understood. Most laymen and many doctors really believe that certain so-called "antisceptic solutions" do great good, because they are pleasantly scented and often prettily colored and perhaps have a little bite or sting when sprayed into the nose and throat or when gargled. As a matter of fact they do little more good than does the application of perfume to a dirty skin. Just as soap and water are displacing the perfume bottle, so a good cleansing solution, used for purposes of irrigation, is replacing the more or less sweet-scented "antiseptics" formerly sprayed into the nose and throat.

It has been found by carefully conducted experiments, that so-called antiseptics cannot be used in the nose and throat in sufficient strength to kill bacteria, without doing harm to the mucous membranes. Most antiseptics aren't sufficiently effective to make a germ sneeze if he were tied in it.

For cleansing the nose and throat the following outfit is recommended for home use. A two-quart porcelain irrigating container fitted with four feet of rubber tubing (a fountain syringe will do) is suspended two to four feet above the head. A nasal tip that produces a spray rather than a direct stream, is preferable.

The container is filled with boiled water at a temperature of from 116° to 188° F. A heaping teaspoonful or more of the following salt mixture is added to the two quarts of water:

Table salt	3 parts
Borax	2 parts
Soda	1 parts

This salt mixture may be prepared by placing three tablespoonfuls of salt, two of borax and one of soda, on a clean paper and rolling (use rolling pin or round bottle) until all lumps are broken. Thoroughly mix and place in wide-mouth bottle for use.

This salt mixture quickly dissolves in the hot water and makes a good cleansing, but non-irritating, solution. If desired it may be scented by adding a drop or two of cinnamon or sassafras oil, or both, which has been well dissolved in alcohol (five drops of oil to the ounce of grain alcohol).

To irrigate the nasal cavities and upper part of the pharynx, lean the head forward over the sink, breathe through the mouth, hold the nasal tip in on nostril and let the water flow (slowly at first) into one nostril and out of the other. After using about half of the fluid, change to the other nostril and continue irrigating.

A little water does little good. At least one quart and perferably two or three quarts should be used. The water must be as warm as the mucous membranes can well stand; cold or tepid water does no good. Most disease-producing bacteria cannot long resist a temperature much above body temperature. The increased temperature of the solution, therefore, renders it both cleansing and slightly antiseptic.

For gargling the throat, add one teaspoonful of the salt mixture to a glass of warm water (same temperature as above) and gargle thoroughly until the entire glass of water is used. The gargle may also be scented with a drop or two of alcoholic solution of volatile oils if desired.

This solution as recommended for a gargle, makes a very efficient tooth wash, because it thoroughly cleanses without doing any possible harm to teeth or gums.

After irrigating the nose and throat in this manner it is best not to go immediately into very cold air. After ten or fifteen minutes the membranes are again thoroughly coated with mucus and cold air does not affect them. Many of our patients have been using this method of cleansing the nose and throat for the past two years and in nearly every case they have been made more resistive to colds.

It must be understood that the purpose of this irrigation is not to kill germs, but to cleanse the nose and throat and render the membranes resistive to germ invasion.

Some people, especially those living in very changeable climates, suffer almost constantly from colds and catarrh of the nose and throat. In such cases, from the inflammation so caused, adhesion pockets develop in the upper pharynx and behind the tonsils, and these, because they retain mucus, particles of decomposed food and often pus, constitute a constant scource of irritation, a constant "dropping of mucus" into the throat, bad breath and infection for the whole naso-pharyngeal tract.

The successful treatment for such a condition is finger surgery. By this we refer to an operation done by passing the finger behind the tonsils and soft palate and thoroughly freeing the pharynx from all such retention pockets. This operation when thoroughly done and when followed by irrigation and osteopathic treatment almost never fails to give permanent relief from chronic colds.—*The Osteopathic Magazine.*

Graphic Charts

The Use of the Logarithmic Scale for Charting Statistics

By John Wenzel, Graphical Statistician

DURING the past two or three years there has been a marked increase in the use of diagrams for the graphic presentation of facts. Many publications are using graphic charts regularly to show either financial fluctuations or manufacturing and merchandising statistics. It is the exception rather than the rule to find any one to whom the graphic chart does not speak an intelligible language.

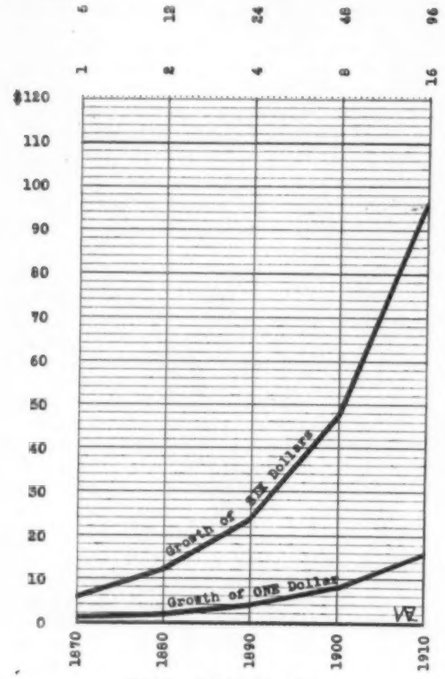


Fig. 1. Arithmetic chart

The simpler forms of diagrams are commonly understood by the reading public. Nearly everyone can read the bar diagrams in which the relationship between quantities is shown by horizontal bars of different lengths. When these bars are placed on end, the varying heights of the "chimneys" tell their story easily. The circle with the shaded sector which looks like a piece of pie on a plate shows the relationship between a part and the whole in a manner that all can understand. Many of the diagrams that consist of one or more zigzag lines crossing a field of horizontal and vertical rulings tell a more or less definite story to the average man.

There is, however, a diagram which has frequently appeared in public print in which the horizontal rulings instead of being all the same distance apart, are spaced nearer together, the greater their distance from the bottom of the chart. The vertical rulings are the same distance apart. These are called logarithmic charts, and they deserve to be more widely known and more frequently used than they are because they present facts in a more truthful and reliable manner than any other variety of chart, especially when it is desired to compare the ratio of growth of large and small quantities on the same chart.

For a long time it has been possible to obtain paper with both the vertical and the horizontal rulings spaced according to the logarithmic scale. This, however, is useful to engineers only and is not the kind that the statistician knows as logarithmic paper. The paper used for statistical work has the horizontal rulings spaced according to the logarithmic scale and the vertical rulings spaced equal distances apart according to the arithmetical scale. This is sometimes called "arithlog" paper, a name which accurately describes its distinctive features. Only recently has it been possible to obtain paper ruled in this manner.

A logarithmic chart is not nearly as complicated or obscure as the name would indicate. A knowledge of the use of logarithms is unnecessary either for plotting the curve or for its correct interpretation. The horizontal rulings are spaced in proportion not to the numbers themselves, but to their logarithms, and is similar to the scale on the slide rule.

The logarithm of four is more than half as large as the logarithm of ten. That is why in Fig. 2 the distance between the horizontal rulings marked four and ten is much less than the distance between one and four.

By measuring up from the base line. the distance from one to two will be found to be the same as the distance from two to four, and from four to eight. By measuring up the same distance from eight, the sixth fine ruling above ten will be reached, which represents sixteen, and so on to thirty-two, sixty-four, one hundred and twenty-eight, etc. Each of the above quantities is double the preceding, the rate of increase having been the same in every case.

On arithmetically ruled paper as in Fig. 1, the horizontal rulings are the same distance apart, so that the distance on the scale at the left is the same from ten to twenty as it is from twenty to thirty and thirty to forty. A curve which rises in ten years from ten to twenty represents an increase of 100 per cent. A curve which starts at one hundred and rises in ten years to one hundred and ten represents an increase of only 10 per cent. In Fig. 1 a 10 per cent increase is shown by the same angle as a 100 per cent increase. It is therefore evident how impossible it is to get the correct comparison of the rate of increase between a large quantity and a small quantity when charted on ordinary arithmetically ruled paper.

This is shown very clearly by charting the same data on both arithmetically and logarithmically ruled paper, as has been done in Figs. 1 and 2. Here the rate of growth of an investment of $1 was compared with a similar investment of $6. Both investments doubled every ten years. The growth of the two investments was as follows:

1870	$1.00	$6.00
1880	2.00	12.00
1890	4.00	24.00
1900	8.00	48.00
1910	16.00	96.00

The rate of increase was the same in both cases and yet the angles at which the two curves rose in Fig. 1 were so unlike that it was hardly conceivable that there was any relationship whatever between the two curves. This shows how misleading it is to attempt to compare large and small quantities on the ordinary arithmetically ruled paper.

The correct relationship between the two curves can be shown by charting them on logarithmically ruled paper as in Fig. 2. The rate of increase is the same in both the upper and the lower curves, therefore the two curves are parallel. Because the rate of increase is uniform throughout the whole period from 1870 to 1910, the curves representing the two investments are straight. The curves in Fig. 1 give the erroneous impression that the larger quantity increases much more rapidly, especially between 1900 and 1910.

The mistake in attempting to compare large and small quantities on the same arithmetically ruled chart is shown by a comparison of Figs. 3 and 4. Here are

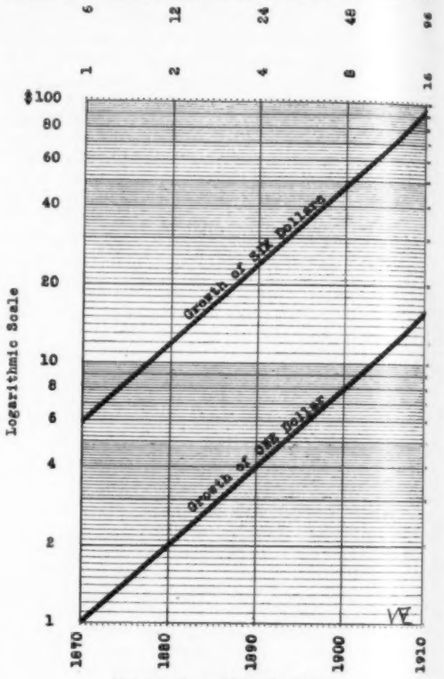


Fig. 2. Logarithmic chart

charted for a period of years the total sales and sales cost which includes the salesmen's salaries, salesmen's expenses and advertising expenses. The details of these figures are shown in the tabulation in Fig. 5.

In Fig. 3 the data is charted on arithmetically ruled paper. The "Total Sales" curve being much larger than all the other curves stands out prominently at the top of the chart, while the salesmen's salaries, salesmen's expenses and advertising expenses, which added together make up the sales cost, are all so near the base of the diagram that it is impossible to compare the latter with the former. When this data is charted on logarithmically ruled paper as in Fig. 4 the ratio of increase or or decrease becomes instantly apparent. For the first time it is possible to see that in the advertising expenses and salesmen's expense curves there has really been more fluctuation than there has been in the Total Sales curve, the growth of which is much more spectacular in Fig. 3 than it is in Fig. 4.

The Cost Index which appears in Fig. 4 is a very useful addition to the chart. It shows how many cents out of each sales dollar goes to sales cost. This is read from the bottom of the chart as though the base line were one, leaving four ciphers off of each number in the scale. In 1910 the Cost Index was 21 cents; in 1911 it had dropped to 17 cents; in 1912, to 15 cents, while in 1913 it had reached 12 cents. In 1914 it had gone back to 16 cents. Since then it has been going down until it was again 12 cents in 1916. The Cost Index line which is usually plotted in red ink is one of the most helpful features of this form of chart, as it enables one to get the exact situation at a glance.

Recently a sales manager charted all the expenses that went into the sales cost and because the chart looked like Fig. 3 he concluded that the business was in prime condition. He showed the charts to a friend who suggested that he might get a new view point of his business problems by using logarithmically instead of arithmetically ruled paper. The result was startling; he found that many of the curves presented an entirely different aspect, and that his business was not as prosperous as he had supposed.

In Fig. 2 the base line of the chart is marked $1; in

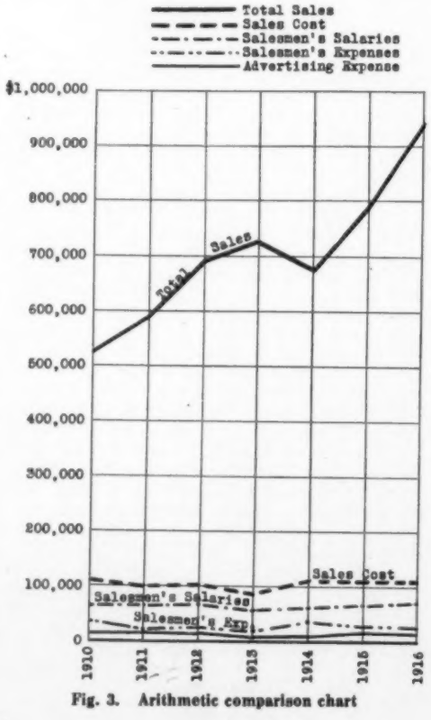


Fig. 3. Arithmetic comparison chart

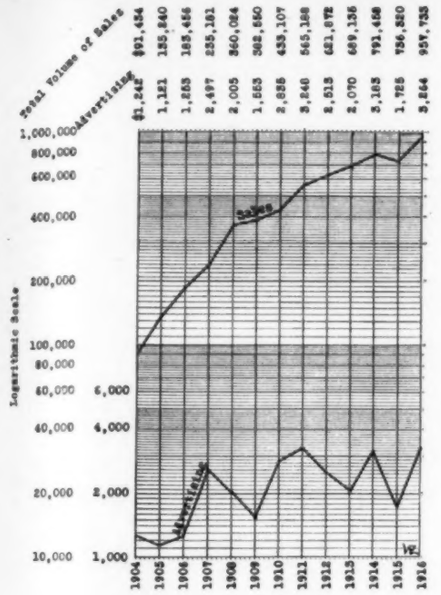


Fig. 6. Double scale chart

Fig. 3 the base line is marked $10,000. The general rule is that the base line should always start with zero, but this refers to arithmetically ruled charts only. In logarithmic charts the base line may be one, ten, one hundred, one thousand, ten thousand, or a million or any power of ten. By pasting four sheets together, one above the other, it is possible to compare on the same sheet fluctuations in curves that vary from $1 up to $100,000,000.

It is often necessary to show on the same chart the curve of a very small quantity and also the cruve of a very large quantity. For example: To compare the rate of increase of the advertising expenditures during thirteen years with the total sales during the same period it is necessary to have two scales in order to show these curves upon the same sheet. One is for reading the larger figures and one is for reading the smaller figures. Instead of pasting several charts together endwise to permit the plotting of the two curves in their relative positions, they can be plotted as in Fig. 6, where a double scale is used. The left-hand scale applies to the sales while the right-hand scale applies to the advertising.

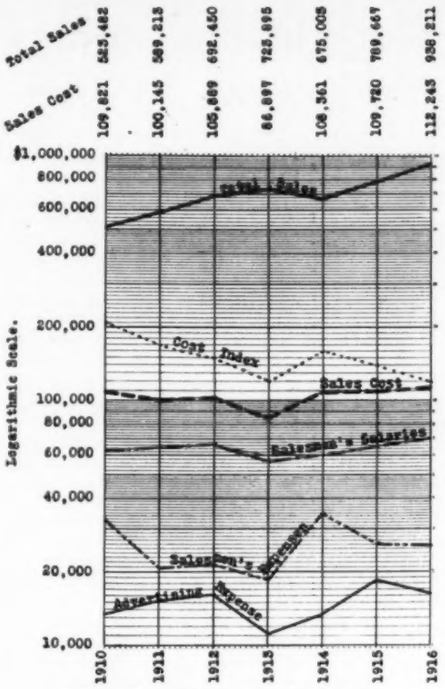


Fig. 4. Logarithmic comparison chart

Year	Total Sales	Sales Cost	Salesmn Salary	Salesmn Expense	Adv. Expense	Cost Index
1910	$523,482	$109,821	$65,259	$33,002	$13,560	21
1911	589,218	100,145	65,218	20,850	15,105	17
1912	698,450	105,889	66,490	21,490	16,212	15
1913	725,895	86,897	57,211	18,856	11,130	12
1914	675,005	108,361	60,576	34,575	13,445	16
1915	789,667	109,780	65,110	26,021	18,589	14
1916	938,211	112,243	70,344	25,647	16,232	12

Fig. 5

A very useful feature of logarithmic paper is for forecasting sales or expenses. Suppose it is desired to know the estimated value of fountain pens manufactured in 1916 in the United States, the only available data being as follows:

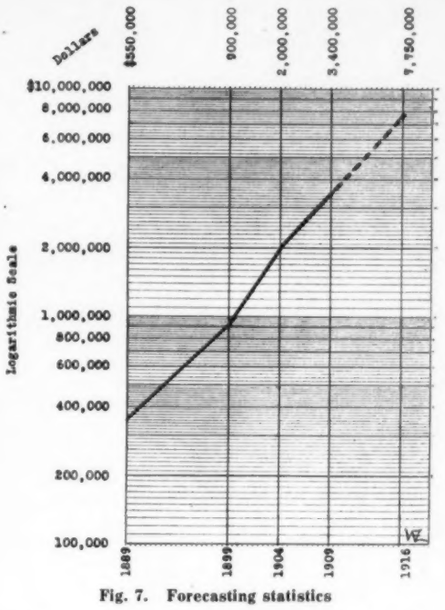


Fig. 7. Forecasting statistics

1889	$ 350,000
1899	900,000
1904	2,000,000
1909	3,400,000

By plotting the foregoing figures and projecting the curve to 1916, as in Fig. 7, the value for that year is $7,750,000, which is said to be a very close estimate of the value of fountain pens produced in 1916.

The distance between the 1889 vertical ruling and the 1899 vertical ruling was selected as a suitable distance for a ten-year period. As the next period of time was five years, one-half of the distance was necessary to locate the 1904 ruling. As the period of time from 1909 to 1916 was seven years, the distance was proportionately larger, being seven-tenths of the distance from 1889 to 1899.

This is only one of a very large number of calculations that can be quickly made by using logarithmically ruled paper.

Daylight Saving*

By Dr. George Frederick Kunz

THE "Saving Daylight" movement, which at the outset was treated as of little consequence by many, gained such headway in the past few years that it has at last been adopted and tried by the leading European nations with most satisfactory results.

This could not have been the case had not the proposed change of time been based upon the normal tendency to awaken earlier on the bright spring and summer mornings than on the duller and darker mornings of autumn and winter. Because of this there cannot be any hardship involved in getting up at five or six o'clock in spring and summer, instead of at six or seven o'clock. This being conceded, the worker in any trade or profession where more or less fixed hours are maintained, would enjoy the inestimable gain of a full hour's daylight and sunshine at the end of the day's labor for recreation, exercise, or repose. The gain in health and strength thus insured would alone make this reform a most desirable one.

And now at last, in the throes of the world war and under the economic pressure resulting therefrom, first Germany, and then Austria, England, France and Italy, and Holland as well as the Scandinavian countries, have adopted this measure and have set it in operation last spring, and we have now an opportunity to gauge the extent of the benefits conferred, although with the constant preoccupation of war preparations and the daily shifting hopes and fears aroused by the changing phases of the conflict, less definite information is available than would otherwise have been the case.

At midnight of September 30th, 1916, the "Sommerzeit" came to an end throughout Austria-Hungary, and the hands of all the clocks and watches were moved back one hour so as to bring the timepieces again in accord with standard time. The "Sommerzeit" had lasted for five months, from April 30th, and the consensus of opinion was that the experiment had been altogether successful, more especially in the saving of expense for illumination. The gas-consumption by the people of Vienna is said to have been reduced 4,500,000 cubic meters (158,915,200 cubic feet), resulting in a saving of 700,000 crowns, or $142,000. The municipal gas-consumption was reduced 400,000 cubic meters (14,125,800 cubic feet) in the same period.

In Germany the replies received from a number of industrial and other enterprises in answer to inquiries sent out by the general organization of German crafts and industrial bodies as to their attitude in relation to a renewal of the expedient next year, have been largely in the affirmative. On the other hand, as might be expected, the German government has been petitioned, by the concerns interested in the illuminating industry, to revert to the old order of things, as otherwise their income will be seriously diminished.

In England, a late amendment to the "Summer Time Act" provided that it should not apply to the meteorological service, astronomy and navigation having been already expressly exempted from its operation. This, of course, was essential to avoid confusion in the registration of continuous observations throughout the year, and in the exact comparison with data previously registered. In the rural districts there seems to have been some inclination to look upon the innovation with a little disfavor, it being held that the hours of agricultural labor were already adjusted to the requirements of the changing seasons and of the special meteorological conditions in the course of the season. Of course this is in the main true, and the reform is not as imperatively needed in agricultural regions as in the cities and in the suburban regions in direct dependence upon city life. In any case, the change should not work any hardship in the country, while the farmer, who rises one or two or three hours earlier in summer than in winter, regulates his movements by those of the sun and would be in no wise inconvenienced if the hour of "sun-up" were marked an hour later on the clock than it really was. That the English lighting companies should endeavor to recoup themselves for the decreased demand for artificial light by raising their rates on the smaller amount furnished, as some of them are stated to have done, is a matter that ought to be easily regulated by municipal control and by appropriate legislation, if necessary.

At the semi-annual meeting of the American Railway Association, held November 15th, 1916, the Committee on Standard Time, in its report, advocates an expectant attitude in regard to the "daylight saving" movement. It holds that while the railroads should not antagonize the enactment of a nationwide law in regard to this, any change that would not be made at the same date throughout the entire country would cause serious confusion and the Committee is firmly opposed to anything that would interfere with the present zone system. In this, the advocates of the new summer standard will in the main agree, although the two years' experience of Cleveland, Ohio, has shown that a local change can be both practicable and beneficial in certain instances. What we are striving for is, however, precisely the condition the railroad representatives consider reasonable.

A very ill-considered objection has been made to the systematic introduction of this reform into our country by those who, in their sincere devotion to individualism are inclined to forget that the great mass of people require, and indeed welcome, a little official guidance in certain directions. True it is that if you or I wish to change our clocks and watches there is no law to prevent our so doing, just as there is no law to prevent our rising as early as we please in summer, whatever hour our clocks may mark. But in practice we would find all our engagements and all our arrangements during the day in "most admixed disorder," unless others could be induced to do the same. Thus it is that any change of this kind to be really of practical worth, must be general, and such general change can only be realized quickly by means of official action. Once this official machinery has been set in motion throughout a land, individuals, even those disposed to look upon the change with a degree of disfavor, will find it to their interest to conform to the new order of things, and will almost certainly be converted into advocates of it when they shall have experienced its manifold benefits.

*Read before Section I—Social and Economic Science—of the American Association for the Advancement of Science.

The Healing Art—I*

Legends and Lore of Its Genesis

By Raymond Crawford, M.A., M.D., Oxon. Physician to Kings College Hospital, and King George Military Hospital, London; Fellow of Kings College, London

We are apt to regard the history of medicine as a development of only modern growth; yet, if we look carefully into the oldest extant literature, we may see that even then the mind of man was occupied in speculation as to the origin of the art of medicine and in attempts to explain its progress to the stage at which he found it. Thus in the Rij-Veda we find the prevalent belief in the divine revelation of the art tempered by the assertion that in the foodstuffs and of medicinal simples animals were the preceptors of mankind. If we then pass on a thousand years to what we may call the threshold of scientific medicine, we shall find a Hippocratic treatise devoted to establishing the position of medicine as a natural corollary of dietetics. So early may we discern a strain of rational empiricism leavening the lump of theurgy and superstition, that bids fair to occupy the whole arena of early medicine.

We see, then, that ancient literature recognized three springs of medical knowledge—a divine source, an animal source, and a human source—and I propose to advert briefly to the first two of these, leaving the last for consideration on some future occasion.

BELIEF IN DIVINE SOURCE OF MEDICAL KNOWLEDGE

Hindoo Medical Legend.—Hindoo medical legend affords a typical account of the divine exposition of medical knowledge, and of its transference to mankind. Like the Nahuans of ancient Mexico, the Hindoos recognized four successive ages in their chronology. In the first age mankind remained virtuous, happy, and free from disease, for had not Brahma, the supreme creative being, given him the four immortal Vedas—the Rij, Yajur, Sama, and Atharva—containing all the knowledge required by mankind during the first age. It should be remarked, in passing, that these Vedas, replete as they are with samples of curative, as well as of preventive medicine, belie an origin in an age exempt from all disease. In the second age man fell away from virtue and disease appeared, to the curtailment of life and the impairment of memory. In the third age half of the human race was given over to depravity. In the fourth and present age the moral and physical corruption of man grew apace, so that disease flourished exceedingly. These four ages approximate closely to the four Biblical epochs of the primordial bliss of Eden, of the fall of Man, of the state of the earth before the Flood, and of the age that followed thereafter. Such compassion had Brahma for man's suffering in this fourth age that he produced a second class of books called Upavedas, or supplementary Vedas, one of which, the Ayur-Veda, was intended to teach the right manner of living, and the prevention and cure of disease, so that man might live happily in this world, in preparation for further happiness in a future state.

The Ayur-Veda, or Science of Life (*ayur* = period of living; *ved* = to know), is a sacred medical record of high antiquity, maintaining the general outline of the yet older Atharva-Veda. It shows that medicine in ancient India was part and parcel of theology, and that the same priests as controlled religion controlled also the treatment of disease; it was not till the end of the Vedic period that the physician began to shake himself free of priestcraft and to assume an independent individuality. Fragments only of the original Ayur-Veda survive, preserved in the Shastres or Commentaries on the Vedas. It is said to have consisted of 1,000 sections, each of 100 stanzas. The divine Brahma, with truly human insight, realizing the impossibility of learning so large a work, provided an abridgment in eight parts. Nowadays, such is the quality of mercy, that when a System of Medicine is published in no more than seven volumes it is accompanied by an abridgment in one. Divine exponents are the first to handle these divine books of healing in a celestial entourage. Brahma, so say Charaka and Susrata, first instructed the god Dakhsa, the Prajabati, in the Ayur-Veda. This god compiled a book, the Chikitra-Darshana, which he communicated to the two Ashwins, or offspring of Surja, the Sun. These Heavenly Twins became the medical attendants of the gods, on whom they performed miraculous cures, and authors also of important medical works. Indra, King of Heaven, was so impressed by their wonderful cures that he induced them to instruct him in the Ayur-Veda.

Various legends exist telling of the transference of medical knowledge from heaven to earth. One relates how the Munis or sacred sages, grieved at the melancholy spectacle of disease, met in council in the Himalayas and decided to ask the help of Indra, to whom in heaven they sent one of their number. Indra duly instructed their emissary in the Ayur-Veda, and on his return he related to the Rishis, or sages, the principles committed to him. In the strength of this knowledge the Rishis succeeded in living in happiness and health to extreme old age, wrought many cures on men, and wrote valuable works on medicine. Foremost in skill was Agnibesa, who instructed practitioners on earth, as the Prajabati did in heaven. Agnibesa's treatise was amended later by Charaka.

The number of different gods associated with healing in Hindoo mythology is due to the readiness with which, in India, one god supplanted another in popular favor.

One other Hindoo legend calls for mention, if only because it recognizes the association of the serpent with medicine; in view of the prevalence of serpent worship in ancient India it is remarkable that more is not heard of it in Hindoo myth. The legend runs[1] that "the Vedas were lost in the deluge, but were recovered by the great serpent Ananta. At the churning of the ocean by the gods and demons the water of the ocean was converted into milk, and then into butter, from which precious gifts were derived. Among these was Dhanwantari, the physician, or holy sage, the possessor of the water of life drunk by the immortals." Indra instructed Dhanwantari, in heaven, in the Ayur-Veda, so that he practised medicine with great success among the gods. But seeing the many maladies and the misery of mankind he came on earth to cure them. As king of Benares his miraculous cures gained such fame that the divine sages resolved to solicit his aid; Susruta was chosen to be the one instructed by him. To the conservative sentiment of Dhanwantari the Ayur-Veda seemed all-sufficing, but so voluminous that he charged Susruta to abridge and arrange it for easier comprehension. Dhanwantari began by expounding surgery, as formerly there were no diseases among the gods, and only wounds required treatment; his exposition is contained in the six books of Susruta, which seem to have been committed to writing about 500 A. D. The Commentaries of Charaka and Susruta supply the groundwork of the more recent systems of Hindoo Medicine; the disciples of Charaka became physicians, those of Susruta surgeons.

The Vedas present the usual blend of prayer and invocation, of magic and spells, familiar in primitive medicine; but through all this flows a thin stream of rational empiricism, touching, on the surgical side, such procedures as the extraction of arrows, the dressing of wounds, amputation of legs and their replacement by iron substitutes, castration, and removal of eyes; and on the medical side the action of numerous herbs and the healing power of water. The oldest, the Rij-Veda, mentions no less than 1,001 drugs, of which 760 were herbs. Vedic physicians lived as herbalists in houses surrounded by gardens of medicinal herbs, but they were instructed to seek knowledge also from shepherds and huntsmen, no doubt in the belief that they in turn will have learnt much from animals. It is noteworthy that many of the instruments described by Susruta are constructed after the form of beasts and birds. The anatomical knowledge of the Vedas is of the most elementary kind, and consists in little more than an enumeration of the chief component parts of the body, while their physiology stagnates in the expansive conception of breath as the source of vital power.

Greek Legend: Asclepius. No good purpose would be served by multiplying illustrations of the doctrine of the divine revelation of medicine from the records of Egypt, Assyria, Persia, Judæa, and other nations; in essence, they are everywhere alike. Greek legend, however, will repay fuller consideration, for the study of origins serves to throw light on its traditions and symbolism.

Among the gods of Greece, Apollo, son of Zeus and Leto, is the *doyen* of healers, while under his guidance Pæon ministered to the medical needs of the gods in Olympus. Other gods and goddesses are endowed with some share of the faculty of healing; thus, both at Athens and Epidaurus Athena bore the occasional surname "Health," and Asclepius was said to have received from Athena the blood of the Gorgon; that from the veins on the right side he used for the healing of men and the restoration of life, that from the veins on the left for their destruction. Asclepius is the medium by which Greek medicine came down from heaven to earth. In the earlier legend he stands out as a medical superman, and only later does he assume complete divinity. He was the son of Apollo and Coronis, who was slain by Artemis for infidelity to Apollo. As her body was about to be committed to the funeral pyre, Apollo snatched away the child Asclepius (whether by artificial abortion or by Cæsarean section we are not told), and gave him to Chiron, the Centaur, to instruct in the cure of diseases. One legend has it that Chiron acquired his knowledge from Apollo and Artemis; another, from his own observation and experience, gained while hunting on Mount Pelion. Hunters, as we have seen in Hindoo myth, were believed to enjoy special facilities for acquiring such knowledge; certainly acquaintance with the favorite foods of animals must have facilitated approach, and the baiting of traps and pitfalls. Homer[2] tells us that it was Chiron who instructed Achilles in the cleansing and healing of wounds, and Achilles transmitted his teaching to his friend Patroclus. Pindar[3] attributes the use of charms as well to Chiron. So great was the skill of Asclepius, that we find Castor and Pollus, the Greek Heavenly Twins, insisting on his accompanying the expedition of the Argonauts. Ultimately he acquired the power of restoring the dead to life, but this achievement proved his undoing, for Pluto, in alarm for his kingdom, complained to Zeus, who slew him with a thunderbolt and cast him down to Hades. He left behind him two sons, Podalirius and Machaon, and at least four daughters, Hygieia, Panacea, Egrea, who married a serpent and was changed into a willow, and Jaso; from which of these Hippocrates, who was reputed to be a descendant of Asclepius, was derived, we are not told. The exploits of the warrior surgeons, Podalirius and Machaon, are recounted by Homer, and to his record we need only add, that to Podalirius was attributed the discovery of the art of bleeding. On his return from Troy he was driven by a storm to the shores of Caria, where a shepherd, learning that he was a physician, took him to the king, whose daughter was sick. He is said to have cured her by bleeding her from both arms, while for his fee he received his patient in marriage, along with a rich grant of land.

Asclepius was represented in Greek art with a serpent twined round a staff; a dog and a cock not infrequently figure among his emblems; on a coin of Epidaurus a dog lies beneath the throne on which he is seated. The cock is his habitual offering of sacrifice, and there are the inevitable legends to explain both serpent and dog. Asclepius, it is said, was shut up in the house of one Glaucus, who had sought his aid; while he was deep in thought there came a serpent, carrying an herb in its mouth, and twined itself round his staff. Asclepius killed the serpent, and used the herb to restore the dead to life. The presence of dogs in the sanctuary of Asclepius was explained by a legend that, when an infant, he was suckled by a bitch. According to an inscription found in the temple of Asclepius at Peiræus the dogs were fed on the sacrificial cakes. If we may credit Sextus Empiricus,[4] the flesh of these sacred dogs was given to the patients to eat as medicine. As we shall see presently, the dog was credited with imparting to man knowledge both of herbs and of the healing of wounds; may be, then, its flesh was at one time eaten sacramentally, as embodying the god of healing. There was another legend that Asclepius had been suckled in infancy by a goat, and Pausanias blends the two legends into a story of his being suckled by a goat and guarded by a dog. According to Ælian,[5] dogs, goats, serpents, oxen, and pigs have the power of foreseeing an impending epidemic; it is perhaps worthy of note that three of these animals figure in the legends and symbolism of Asclepius. Inscriptions found in the temples of Asclepius record the healing of blindness by dogs licking the eyes, and the cure, by licking, of a tumor on the neck of a boy. Other gods of healing, for instance, the Sumerian Gula and the Babylonian Marduk, are represented accompanied by a dog.

The Serpent in Relation to Healing.—The association of Asclepius with the serpent is of very great interest and importance. The association is not peculiar to him, for his Phœnician counterpart, Eshmun, likewise has a serpent as his symbol; so has his own daughter, Hygieia, who is represented feeding a serpent from a saucer. In Madagascar, too, Ramahavaly, the god of healing, was held to be the patron of serpents and to employ them in his service, for good or for harm. When his image was

*A presidential address delivered before the Section of the History of Medicine of the Royal Society of Medicine, reported in *The Lancet*.

[1] T. A. Wise: Hindu System of Medicine.

[2] Iliad, XI., 827 [3] Pyth., 111. [4] Ed. Bekker, p. 174
[5] Nat. Anim., VI., 16.

carried in public, each of his attendants held a writhing serpent in his hand, to inspire awe in the beholders. The Naga (serpent) tribes of Cashmir acquired their medical skill from the serpent, and the ancient Celts by drinking serpent broth. In India it is common to make clay or brazen images of the serpent, and offer sacrifice to them on behalf of the sick, just as Moses in time of pestilence set up a brazen serpent, that all might behold and be cured. The inhabitants of Southern Arabia regarded medicinal waters as haunted by serpent jinn, and in a certain African lagoon dwelt a serpent that relieved madness, and in an Algerian well one that cured sore eyes. There was a prevalent belief in the Middle Ages that the household snake, if not propitiated, would prevent conception.

In the legends of Asclepius we have already encountered the belief that the serpent has knowledge of herbs that can restore the dead to life, and we meet it again in the story of Polyidus. The same belief is current in German, Italian, and Lithuanian folk-lore. A Syrian story[6] tells how the king of the serpents restored three slain men to life by washing them with the waters of life; and Russian folk-lore represents the serpent as possessing a magic water that heals all wounds, restores sight to the blind, and vigor to the cripple. One Russian tale describes a wonderful garden, in which were two streams of healing and life-giving water, and round it was coiled a serpent. In Eden the serpent knew well the properties of the Tree of Life.

Sacred snakes were kept in the temple of Asclepius, and fed with honey-cakes; at Epidaurus certain native snakes were sacred to Asclepius. The temple snakes were credited with effecting cures by licking patients with their tongues. Similarly the blind emperor Theodosius received his sight by a serpent laying a precious stone on his eyes, and Siegfried became invulnerable by bathing in the blood of the dragon.

Besides the tales of miraculous cures by serpents, there is a crop of legends that seek to explain how man acquired the healing knowledge of the serpent. The serpent, by touching his ears or his lips, makes him to understand the voices of birds, who have the gift of foretelling the future, and the language of plants, so that they disclose to the hearer their secret medicinal properties. That serpents should know the language of birds was not unnatural, for they were believed to be generated from the blood of birds; this idea may be referable to the fact that serpents eat the eggs of birds. Yet another widespread belief held that the medical skill of the serpent could be acquired by eating its flesh; this is merely an illustration of the general belief that the properties of animal, man, or god may be acquired by eating the possessor.

Cicero says that the ancients explained the connection of the serpent with Asclepius by the fact that, like the healing art, the serpent yearly sloughed its old skin and put on a new; but, in all probability, Asclepius was originally himself a serpent that subsequently became transformed into an anthropomorphic god, for whom conservative religious sentiment preserved the symbol of the serpent. This same conservatism is seen in the custom of sending a sacred snake from an existing sanctuary whenever a fresh one was established. It is not clear why the serpent is represented twined round a staff, just as it was coiled round an apple-tree in the garden of the Hesperides. Can this, too, be a symbol?—a symbol of some tree-spirit standing yet further back than the serpent in the pedigree of Asclepius?

Zoologists tell us that the serpent is by no means an intelligent animal, despite the fact that it became the legendary embodiment of knowledge, and of medical knowledge in particular. The serpent of Genesis was more subtle than any beast of the field. The strange sinuous form, the mysterious gliding movement, the annual sloughing of the skin with its annual renewal, the weird fascination of its victims—all these must have served to endow the serpent with the homage of wonder that attaches, often so inaptly, to the unknown; and perhaps the deadly poison of the almost imperceptible bite may have seemed to link it appropriately to the science of herbs, that bring life or death to man.

BELIEF IN ANIMAL SOURCE OF MEDICAL KNOWLEDGE

From this brief consideration of the serpent, to the ancients so much more of a god than an animal, we may pass to the kindred belief that man owed his knowledge of medicine to observation and imitation of the practices of animals.

The Dog.—From the evidence of geology we know that the dog was the first animal to be domesticated, and man must have soon observed its habit of licking its wounds, as cats and horses also do. He must have noted again and again how much more readily his dog's sores healed than his own, and not unreasonably attributed this to the licking. It is no matter for surprise, then, that we should find this method of healing wounds employed in the temples of Asclepius by the tongues of dogs and of serpents. In quite recent years licking of sores by the tongue of a dog was held in repute both in Scotland and France.[7] In the absence of any knowledge of the essential conditions that govern the healing of wounds, it was a natural conclusion that the licking was of therapeutic intent, and akin to the cleansing that was the central feature of the primitive treatment of wounds. There is no certain evidence that licked wounds of dogs heal more readily than those which cannot be reached by licking; and the contrast with the slower healing in man would seem to be due to the wide difference in immunity to sepsis between man and dog, for the dog is highly refractory even to subcutaneous injection of pyogenic organisms. There seems no reason to suppose that by licking their wounds dogs imbibe toxins that produce specific antibodies which assist them in the struggle against invading organisms, for they appear to have little or no need of such assistance. When one reflects how a child sucks an injured finger; how he puts his hand to a hurt leg or a bruised head; how hard each one of us finds it to keep his fingers from a scab, it seems not improbable that underlying all these tendencies is a common instinct to touch the injured part with the tongue or hand to determine the injury and, if possible, to remove the cause. If, in the case of the tongue, this should promote healing by the removal of dust and particles of dirt, this contingent benefit is merely incidental and does not indicate a definite therapeutic purpose.

There is a very ancient tradition that dogs, when they are ill, eat grass or standing corn to relieve the stomach by vomiting and purgation, and Ælian[8] says it was from this that the Egyptians gained their knowledge of purgatives and emetics. Aristotle says that wolves do the same, and he might also have included cats. Ælian adds that dogs relieve themselves in this way of worms and of the excess of bile which causes rabies. The grasses that dogs eat have been identified as *Triticum caninum* (dog-wheat), *Agrostis canina* (brown bent-grass), and *Cynosurus cristatus* (dog-grass). From observation of my own and other dogs I feel sure that dogs do not eat grass, exclusively or even chiefly, when they are sick, and certainly not with the purpose of exciting vomiting or purgation. They are most prone to eat grass immediately on reaching green fields after a spell of town life; as a rule they cease to eat it, or do so very rarely, after a few days in the country. I have never seen the grass produce actual vomiting; it is usually hawked back, churned up with saliva, and has probably seldom passed far down the gullet. When not regurgitated I have never known it to cause diarrhœa; any looseness of the bowels is referable to the increased exercise that the dog takes in the country as compared with a town. The number of human beings who chew grass-bents is quite as large as that of dogs that chew grass, and I have an impression that the habit is far more common among town-dwellers visiting the country than among country-folk. The human being certainly chews it because he likes the taste, and avoids swallowing it for fear of exciting vomiting. I strongly suspect that there is some subtle aroma of the grass that tickles the dog's palate, and seeing how much misery a dog suffers in the prospect and act of vomiting I am loth to believe that it entertains any therapeutic purpose.

VENESECTION

The origin of venesection was another matter that excited speculation in the ancient world. Pliny[9] says that the hippopotamus invented blood-letting and taught the art to man. This animal, he says, when surfeited with blood, seeks out the sharp point of a newly-cut reed, and pressing against it, opens one of the veins in the thigh, to its immediate relief; then it plasters the wound over with mud. Buffon, quoting P. Labat, repeats the story, substituting a sharp-pointed rock for the reed, and with the picturesque addition that the animal agitates its body to promote the flow, and when it thinks it has lost a sufficient quantity rolls in the mud so as to close the wound. With respect to the various observations involved in these statements, it is the case that the hippopotamus is very prone to exhibit wounds, in spite of the fact that in most parts the skin is two inches thick. These wounds seem to arise in two ways: most commonly as the result of fights, as male hippopotami in the wild state are constantly fighting, regardless of the pairing season, and a wounded animal is often furiously attacked by a comrade; but also as the result of rubbing themselves against any convenient projection, a habit that is common among animals in confinement, and even among such domesticated animals as cows, sheep, and pigs. Again, it is a habit of both hippopotamus and rhinoceros to roll in the mud of river-banks till they are plastered all over, and the mud would certainly adhere more readily to the abraded surface of a wound, giving the semblance of a purposive dressing of mud. The Andaman Islanders use mud in similar fashion as a protective covering, as some think to guard them from the attacks of mosquitoes; but this is probably only part of the truth, as mud is used as a dressing in countries where there are no mosquitoes, probably for no better reason than that it is always handy. In the case of the Andaman Islanders, dwelling as they are almost on the equator, it is more likely used as a protection against the direct rays of the sun. It is not without interest, in considering the association of the hippopotamus with venesection, that the hippopotamus is one of the animals that has a colored sweat, carmine in its case.

The vampire bat has shared with the hippopotamus the credit of having taught mankind the art of venesection; such was the belief of the natives of Peru at the time of the discovery of that country. Peter Martyr[10] describes the rescue from death of a man grievously stricken with pleurisy by the agency of one of these bats, after the human phlebotomist had failed to strike blood. Buffon cites several travelers who assert that large vampire bats suck the blood of men and cattle when asleep; they were believed to render the victim insensible to their bite by agitating the air with their wings and throwing him into a deep sleep. Doubt was thrown on these observations till Darwin, in his "Voyage of the *Beagle*," described how he actually saw a vampire bat sucking blood from the withers of one of the camp horses. These bats attack man less frequently than cattle, and usually when asleep and on an exposed foot. They have a capricious taste, for while one person may sleep in the open air with perfect immunity, another will be bitten almost nightly. This trait is common among blood-sucking animals, such as fleas and lice; whether it is due to difference in the blood, or to the relative thinness of the skin, or to some other cause is obscure. Females, on the whole, seem to be more susceptible to both lice and fleas than males, and I can testify that not one of the least blessings conferred on myself by a long period of connubial felicity has been complete immunity to fleas. The habitual food of these bats is insects, and blood is a prized but infrequent luxury. It is popularly believed in Peru that bites sometimes prove fatal, as the blood continues to flow after the bat has relaxed its hold; may be that, like the leech, it secretes an albumose in its saliva. J. G. Wood says that the wound is sore and inflamed, but never fatal, but he appears to base this conclusion on an estimate of the amount a bat can imbibe, and takes no account of the subsequent loss.

Charleroix,[11] in his "History of Paraguay," refers the discovery of blood-letting to the anta, an animal, "who, when he finds himself overstocked with blood, opens one of his veins with the point of a reed." The anta is the South American tapir, which Linnæus described as a sort of terrestrial hippopotamus. Lyddeker says that their hides are often thickly plastered with mud, probably as a protection against insects, and he adds that they are often found wounded by the claws of jaguars, which are their worst foe; these circumstances taken together show how this legend may have originated.

Yet another ascription of the art of bleeding is to the leech, of which Pliny says[12]: "The action of leeches is looked upon as pretty much the same as that of the cupping-glasses used in medicine, their effect being to relieve the body of superfluous blood, and to open the pores of the skin."

He is a bold man that would venture to assign to any individual, man or animal, the honor, if such it be, of having introduced venesection into medicine; but we must not forget that it may well have originated out of all connection with medicine, as a part of primitive ritual, and that its place in medicine may be merely that of an ancient ritual survival. There is a well-defined stage in the evolution of sacrifice, at which, instead of sacrifice of the man himself, blood only is taken from him, and his life is spared. He is brought to the altar and gashed by the priest. A modification of this is met in the worship of the Phrygian Attis, where the priest draws blood from his own arm and presents it as an offering to the god; he is both priest and victim. In later stages an animal and then an animal's blood is substituted for a man and a man's blood, and later still a plant or the juice of a plant, for red wine is the blood of the plant.

Human sacrifice and ritual cannibalism seem to have reached their zenith among the ancient Mexicans. The ordinary mode of sacrifice was for the priest to slash open the breast and tear out the heart, then to fling the corpse to the worshippers to feed on in their homes. But at

[6] Frazer: Pausanias, II., x., 3.

[7] Gregor: Folk-lore of the North-East of Scotland, p. 127. D'Tharace: Erreurs Populaires et Propos Vulgaires, ii., 178.

[8] Ælian: Anim. Nat., V., 46; VIII., 9. Pliny: N.H., XXV., 51. Aristotle: Hist. An., IX., 6.

[9] N. H., VIII., 40, and XXVIII., 31.

[10] De Novo Orbe, Decade 8, ch. vi., p. 30.

[11] Lettsom: History of the Origin of Medicine.

[12] N. H., XXXII., 42.

many of their religious fasts it was customary to draw blood from ears, eyelids, nose, lips, arms, legs, and body by thrusting the thorns of aloes into their veins and by passing sharp sticks through the tongue. With such practices prevailing among the priesthood, and with medicine in their hands, one may discern a portal by which blood-letting may have found its way into medicine.

The *rationale* of ritual blood-letting lies in the belief that the soul and the life of man reside in his blood. Even Harvey regarded the blood as the seat of the soul, and we find him in his Prælectiones refuting Aristotle, who had asserted the primacy of the heart, and laying it down dogmatically that the "soul is the blood." By eating the flesh or drinking the blood of the victim the worshipper eats the body or drinks the blood of the god, for by the act of sacrifice the victim becomes one with the god; the desire for complete union with the god, by commingling with his substance, is a dominant feature of early worship. The gods themselves are constantly rejuvenated by the blood of sacrifices, so that they may perform with unimpaired activity the vitally important functions incumbent on them. The Mexicans and Nicaraguans used to make effigies of their gods out of meal kneaded with human blood and devour them sacramentally. Blood was also used as a medium of divination, the Babylonian physicians drawing important conclusions from the behavior of the blood drawn in blood-letting. It is interesting to find modern pathologists adopting hæmatoscopy afresh, as a means of divining morbid conditions of the subject.

Whatever the origin of blood-letting, we find the practice firmly established anterior to the earliest medical literature; though not mentioned by Homer, it was well known to Hippocrates, and was an habitual remedy in veterinary medicine in the time of Vergil.[13]

DISORDERS OF VISION

A rich crop of legend grew up around the properties and disorders of vision. Men were puzzled by the closed eyelids of the young, and suggested various explanations of the mode by which they acquired sight. Pliny[14] says that puppies are born blind, and that the length of time before they acquire sight depends on the amount of mother's milk; so that the more numerous the puppies the later do they acquire it. In another passage[15] he states that the swallow employs celandine as an eye-salve to give sight to her young, and that it can restore vision even when the eyeballs have been plucked out. The plant blossoms, he informs us, at the time of the swallow's arrival and withers at its departure. Probably it is from these facts, approximately correct as they are, that it acquired its botanical name "chelidonium," from the Greek χελιδών = a swallow. Pliny recommends its juice blended with Attic honey as a sovereign remedy for films of the eyes, and its virtues have been perpetuated in the use of the term "chelidonia" for eye-salves. The almost dazzling brilliance with which the flower in early spring peeps out from its sombre green cushion of leaves may well have suggested its sympathetic usefulness for dim eyes. Pliny[16] asserts categorically that it was from the swallow that man learnt the use of celandine for affections of the eye, while Ælian regrets that all their labor to prepare such an eye-salve as swallows use has been in vain.

Hawkweed also enjoyed high repute in diseases of the eye. Pliny says that the hawk distils its juice into her eyes to prevent any dimness of vision, and mixed with human milk he recommends it as a cure for all diseases of the eye. It was necessary to postulate the employment of some such specific remedy to explain the marvellously keen sight of the hawk's eyes. Ælian[17] has it that "physicians use this same remedy for eye diseases, nor do they deny that they have learnt it from birds, but prefer to profit by the knowledge."

Fennel, too, stood high in favor in the treatment of diseases of the eye. Both Ælian and Pliny[18] were aware of the fact that when a snake changes its skin the disks over the eyes peel off with the rest, and appear as dry lenses in the slough. Pliny seems to say that the snake takes fennel internally to aid exfoliation, and also applies it locally to the eyes to sharpen its sight, and it was this knowledge that led to its use by man as an eye-salve. In later times euphrasia was used similarly in eye diseases, but according to the doctrine of signatures, as it has a black spot on its corolla, resembling the pupil. When Michael in "Paradise Lost" opens the eyes of Adam to see the future of the world and of its own progeny therein, he

> . . . . . purged with euphrasie and rue,
> The visual nerve, for he had much to see;
> And from the well of life three drops distilled.

[13]Georgics, III., 457, seq.
[14]N. H., VIII., 62.
[15]Ib., XXV., 50.
[16]Ib., VIII., 41.
[17]Nat. Anim. II., 43.
[18]Ib., IX., 16; and N. H. VIII., 41, and XX, 95.

Ambroise Paré asserts that the operation for cataract was discovered by means of a goat with a film overlying the pupil tearing off the film accidentally when scratching itself against a thorn, and in consequence recovering its sight; but Ælian and Pliny[19] reject the accidental character of the goat's discovery. Pliny says that the female goat uses the point of a bulrush and the male the thorn of a bramble for its manipulations, but neither he nor Ælian appreciates the nature of cataract, as Pliny conceives that the cure is due to escape of blood that has surcharged the eyes, and Ælian to the escape of some morbid humor.

The phenomenon of nyctalopia in man was known to the ancients, and goat's liver was eaten for its cure, as it was believed that goats could see by night as well as by day; but in the discussions of the non-medical writers of antiquity there already exists a confusion as to the meaning of the term, some taking it to mean "able to see only at night," and others "not able to see at night." It is an interesting example of the widely prevalent organo-therap of early medicine.

[TO BE CONTINUED]

Self-Induction, the Movement of the Earth, and the Æther

WHEN a wire is moved in a magnetic field, an electric current is induced in the wire. The observation does not teach the experimenter anything as to any influence of the motion of the earth with respect to the æther. The case of self-induction looks different. The carriers of an electric current flowing in a wire, Dr. A. von Schutz argues in the *Physikalische Zeitschrift*, of August 15, 1916, are supposed to be the moving electrons. When the current flows in the direction of the motion of the earth, the velocity of the electrons, relative to the æther at rest (r.t.a.), will be V, V being equal to $v+w$, where v is the velocity of the earth (r.t.a.) and w the velocity of the electrons relative to the wire (r. t. w.). When the wire is turned through 180 deg., so that the current flows with the same intensity in the direction opposite to the motion of the earth, the velocity of the electrons (r.t.a.) will be $V=v-w$. The same diminution of the velocity (r.t.a.) can be produced by leaving the wire at rest, but stopping the current, when $V=v$, and then restarting the current in the opposite direction, when $V=v-w$. Now the question of the magnetic field created by the current enters. If that field depended upon the velocity of the electrons r.t.a., the turning of the wire (about 180 deg.) should alter the velocity of the electrons r.t.a., and thus the magnetic field itself, and a self-induction should be set up, as in the case of the current reversal in a wire. If the motion of the electrons r.t.a. were the decisive factor, any alteration of this velocity should set up self-induction. In reality, however, self-induction is only observed in one case, viz., when the velocity of the electrons relative to the wire (r.t.w.) is changed. This fact can only be explained by the assumption that the magnetic field is induced by the motion of the electrons r.t.w., not by the motion r.t.a., for the turning of the wire does not affect the magnetic field, provided the current intensity, *i. e.*, the velocity of the (negative) electrons with respect to the positive electrons, remains unchanged. Even when the current is stopped and reversed, alteration of the magnetic field and the appearance of self-induction may be prevented by bifilar winding. Thus, Schütz concludes, the magnetic field must be due to the movement of the electrons with respect to the wire, and the movement with respect to the æther is not concerned. The fundamental question whether the æther is at rest, or whether the assumption of an æther might be abandoned would remain open as before.—*Engineering.*

Swiss Industrial and Colonial Fair

FOLLOWING the example of neighboring nations it has been decided to organize an extensive Fair in Switzerland for the purpose of attracting the attention of the trade to the various national products. The first steps were taken at Basle, and the State Council is now occupied with the question. An organization committee is appointed under the presidence of State Councillor Blocher, while M. De Praetere has the technical direction. The object of the Fair is mainly to show specimens of national products, and there will be a general exposition at Basle installed in one of the large buildings also including annexes. A good part of the space will be devoted to products manufactured in Switzerland since the war and formerly imported from foreign countries. In addition, there will be numerous smaller expositions of a special character devoted to different classes of products, and installed in various parts of town. The Fair will last two or three weeks. The object is of course not to sell upon the spot, but on the contrary to take orders and make commercial connections. Next April is the date fixed for the first of these fairs.

[19]Nat. Anim., VII., 14; and N. H., VIII., 76.

Foreign and Colonial Labor in the French Munitions Works

IT is already a matter of public information that the French government has decided to make use of 5,000 Chinese workmen in the establishments devoted to manufacture of war material, and not long since some 1,700 of these workmen landed at the Marseilles port. More recently, two steamer loads brought the remainder of this first contingent which included 466 laborers, 226 blacksmiths, 433 masons, 165 mechanics, 279 carpenters, etc. There are also announced for an arrival in the near future at a French port of some 3,000 Annamites, who are also to be employed for industrial work, and the greater part will be engaged in the shell-loading factories. A contingent of Kabyls had been tried for this class of work, but they do not appear suited for it and had to be sent back, they being unused to anything but agriculture. Another contingent is to be brought from Senegal. According to this, the question of proper choice of Colonial labor is a matter of experiment. It is certain on the other hand, that the colonies would afford large reserves to draw upon.

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Table of Contents

	PAGE
A Religious Ceremony of the Hopi Indians.—By J. Walter Fewkes	226
Main Drainage System of London	227
Picking Ice in City Streets With a Scarifier Roller.—1 Illustration	228
The Metronome in the Workshop.—1 Illustration	228
Additive Compounds of Trinitrobenzene	229
Inviolable Envelopes	229
Europe at Turkey's Door.—By Leon Dominian.—1 Illustration	230
Mechanical Difficulties in the Evolution of the Steam Turbine	231
A Navy Ammunition Depot.—5 Illustrations	232
Analysis of Vocal Sounds Made by Singers	232
Engines for Cargo Boats	232
The Minimum Radiation Visually Perceptible.—By Henry Norris Russell	233
Sugar Cultivation in Ceylon	233
Aeroplane Ambulance Work	233
The Silver Voltameter as an International Standard for the Measurement of Electric Current.—By E. B. Rosa and G. W. Vinal	234
Who Are the Sane?	234
Correspondence: A New Cipher. Platinum as a Gel or Colloid in the Rocks of the Pacific Coast	235
Cleansing the Nose and Throat	235
Graphic Charts.—By John Wenzel.—6 Illustrations	236
Daylight Saving.—By Dr. G. F. Kunz	237
The Healing Art, I.—By Raymond Crawford	238
Self-Induction	240
Swiss Industrial and Colonial Fair	240
Foreign and Colonial Labor in French Munitions Works	240